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Compiled By
CHARLES E. SHAW

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Interesting Herpetological Records from Southern Texas and Northern Mexico

By RALPH W. AXTELL* and AARON O. WASSERMAN**

In an attempt to obtain live specimens of reptiles and amphibians for a regional display of the 1952 A.S.I.H. meeting in Austin, a collecting trip encompassing the Rio Grande Valley area of Texas and northern Tamaulipas, Mexico, was made by Henry Hildebrand* and the authors.** A total of 78 specimens was collected, most of which are in the Texas Natural History Collection (TNHC). The remainder are in the private collection of the senior author (RWA).

Total time in the field and traveling amounted to seven days, from December 26, 1951 to January 1, 1952. A mild "norther" slowed collecting for the first few days, but we enjoyed optimum collecting conditions for the remainder of the trip.

We wish to extend our warmest thanks to the Ted Beimlers of Brownsville, who viewed our efforts with unfailing curiosity and sympathy, and who, through their hospitality, made our stay there very enjoyable.

The giant Mexican toad (*Bufo horribilis*) has been previously recorded only once in Texas by Taylor and Wright (1932) near Zapata, Zapata County.

A single specimen of this species (TNHC 15000) was collected on December 30, 1951, at a location 8.5 miles west of Rio Grande City, and one-half mile north of Garceno, Starr County, Texas. It was taken at the edge of a dirt "tank" around which *Rana pipiens* and *Acris crepitans* were numerous. The toad seems to be an immature male measuring 122.0 mm. from snout to vent. Blair (1947) released several specimens of *horribilis* in the vicinity of Hebbronville, Jim Hogg County, but it is unlikely that the individual discussed here is one of these.

The distribution of spadefoot toads in Texas is less well known than that of other anurans. A collection of *Scaphiopus* representing three species was made on December 31, 1951, about 10 miles south of Hebbronville, Jim Hogg County. This includes *Scaphiopus hombifrons* which has not been previously recorded from southern Texas. All of these ani-

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mals were collected shortly after midnight on an unnumbered macadam road leading to Rio Grande City. No recorded rain fell in the general region (including the Garceno area) for at least three weeks prior to the time these animals were taken. And yet, the spadefoots were numerous on the highway (one or two every few yards). However, the humidity was quite high since the air felt damp and some mist was evident. The wind was from the southeast, and the temperature was in the high fifties or low sixties. The soil was a rich reddish color and of a fine sandy consistency.

Of the 40 spadefoots collected, 35 proved to be *S. bombifrons*. The largest of these measured 54.6 mm. from snout to vent and the smallest 35.5 mm. Brown (1949) gave the range as northwestern and the Trans-Pecos region of Texas. Firschein (1950) reported that several specimens of this species were collected near Samalayuca, Chihuahua, Mexico, in 1947 and again in 1949. W. F. Blair and party collected a number of *S. bombifrons* 10 miles northeast of Lamesa, Dawson County, Texas, in July, 1952.

The 25 *bombifrons* which were preserved were compared with other examples of the plains spadefoot from Dawson, Hutchinson and Armstrong counties of west Texas. The differences between these samples and our specimens were negligible.

The occurrence of this species in southern Texas is not surprising as numerous other vertebrates which are widely distributed in the plains region of west Texas range eastward into the brushlands of south Texas, avoiding the Edwards Plateau. In view of the present evidence, this would seem to be true in the case of *S. bombifrons*.

Of the remaining five animals, four are *S. hurteri* and one *S. couchi*. The largest of the former measures 60 mm., the smallest 32 mm. from snout to vent; and the latter is 63.8 mm.

It should be noted that all of the *Scaphiopus* were collected within a 10 mile stretch of road, indicating the occurrence of the three different species of spadefoots in the same region.

Five specimens of *Holbrookia propinqua propinqua* (TNHC 15001-2 and RWA 535-5) were collected 20 miles E.S.E. of Matamoros, Tamaulipas, Mexico. The individuals, which are all juveniles, were found active on sparsely vegetated sand dunes within 300 feet of the Gulf of Mexico. This record definitely establishes the subspecies *propinqua* as a resident of Mexico and extends its range 20 miles south of its previous known range in Texas.

Our use of the trinomial is in following with the recent paper of P. W. Smith and W. L. Burger (1950) describing *H. p. piperata,* a new subspecies of the keeled earless lizard from northern Veracruz, Mexico. Our concurrence with the nomenclatorial views of Smith and Burger does not mean complete agreement with them, however, for a number of ambiguities were found in their paper which we feel should be pointed out.

Smith and Burger write: "The specimens (*piperata*) are uniformly white below, in contrast to the tawny or yellow venters of most preserved *Holbrookia propinqua propinqua.*" This contrast is apparently set up as

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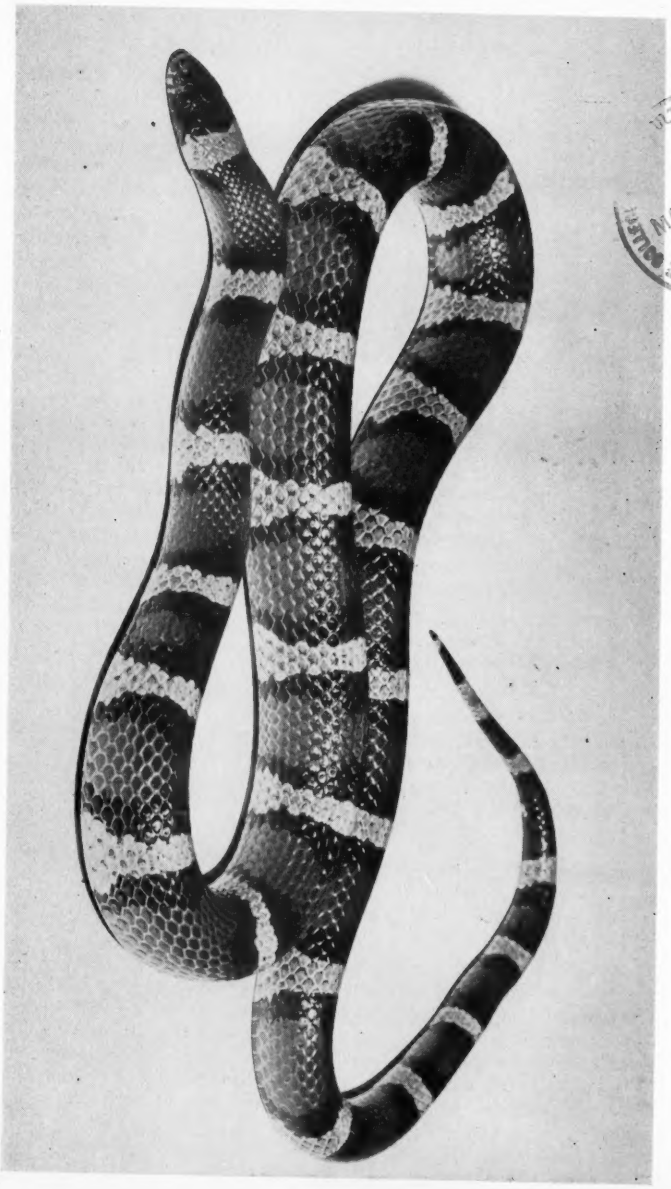
PLATE 1. *Lampropeltis triangulum annulata* x *gentilis,* 992 mm. total length. Collected 1 mile southeast of Hebbronville, Jim Hogg Co., Texas. Photo by Isabelle Hunt Conant.



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one of the differences between the two subspecies, but qualified by inserting "preserved" before the lizard's name. If taxonomic differences involving coloration are to be employed, it would seem to the present authors that the proposed entities used should be in the same state of preservation. Certainly many color differences in reptiles could be found if old preserved material were compared with living or freshly preserved specimens. That *H. p. propinqua* possesses a white ventral surface is a fact well known to anyone who has observed it in life.

The senior author, who has worked extensively with *Holbrookia* in the field and lab, has noted the pinkish coloration of the females not only in *H. propinqua,* as Smith and Burger suggest, but in the gravid females of *Holbrookia maculata, Holbrookia texana,* and as recently pointed out by Shaw (1953) in *Crotaphytus collaris,* and also by Fitch and Tanner (1951) in *Crotaphytus,* and *Gambelia wislizeni.* Of these mentioned, only *maculata* and *propinqua* exhibit this striking color on the ventral surface of the tail.

In order to see how other characters of *piperata* held up, 158 *H. p. propinqua* were examined from all parts of its known range. Eleven were found to have the transverse row of four subequal scales—the key character for *piperata.* These eleven specimens came from widely separated localities and showed no general clinal trend either to the north or south. One of the Tamaulipas specimens herein reported (RWA 533) revealed the scale characteristic, while the remaining specimens showing it were from Aransas, Atacosa, Bexar, and Nueces Counties of Texas. Although a large series (40) were examined from Kenedy County, none displayed the required scalation, but a number closely approached it.

Summarizing this information with some additional observations not discussed at length above, we have:

Differentiating characters set forth by Smith and Burger separating *H. p. piperata* from *H. p. propinqua* and our findings with *propinqua*

piperata	*propinqua*
1. white venter	white venter
2. pinkish coloration on tails of females	same
3. transverse row of gulars in 4 specimens	in 11 out of 158 specimens
4. enlarged supraoculars	enlarged supraoculars
5. elevated, triangular circumorbitals	elevated quadrangular circumorbitals
6. ground color dorsally dark gray finely speckled with white	variable
7. two rows of small dark blotches	same
8. tail bicolored	same

It would seem that morphological differences between *piperata* and typical *propinqua* is not complete, as Smith and Burger have asserted.

Retention of the subspecific name *piperata* in the present paper is based on the meager but significant evidence presented above. To strengthen the evidence in favor of the race described by Smith and Burger, it may be pertinent here to mention the important transition zone between Nearctic and Neotropical faunal elements in southern Tamaulipas.

Without going into much detail here, it should be pointed out that a large proportion of the lowland Neotropical fauna and flora of Mexico find their northern limits within this transition zone, and vice versa. In

addition, many forms that have not been limited have differentiated into separate races on opposing sides of this same region. Reptilian examples such as *Bothrops atrox, Boa constrictor, Laemanctus serratus, Crocodylus moreleti* are limited Neotropical forms; *Masticophis flagellum, Gopherus berlandieri, Holbrookia texana* are limited Nearctic forms; and *Lampropeltis triangulum, Sceloporus variabilis, Cnemidophorus sacki* are forms that have differentiated into subspecies on opposite sides of the zone.

The *propinqua-piperata* split, if there is one, could easily fit in with the last group mentioned above. The answer to this question will be conclusive only after more than four specimens of *piperata* become available for study, and after the range and variability of *propinqua* in Tamaulipas become better known.

Three specimens of *Eumeces tetragrammus* (Baird) (TNHC 14998-99, RWA 570) were taken one mile east of Los Fresnos, Cameron County, Texas. All individuals agree well with published descriptions of this form. The skinks were found in cavities between truncated frond husks of the common introduced palm (*Phoenix canariensis*) found in the valley area. This winter habitat of *tetragrammus* had been discovered some years before by Mrs. Ted Beimler, who very courteously demonstrated her collecting technique; it was through the use of this technique that we acquired our specimens. The lizards seem to prefer half-grown palms, which retain moisture near the proximal portion of their husks. Collecting is effected by disengaging the husks from the tree with a potato fork or similar instrument. The skink, upon being exposed, quickly darts for cover, and one must be alert to capture the creature. This method of collecting is erratic, however, as 25 or 30 trees may be tested without finding a single specimen. At other times, a single tree may contain five or six lizards.

A single specimen of *Lampropeltis triangulum* was taken A.O.R. one mile southeast of Hebbronville, Jim Hogg County, Texas, December 21, 1951. The snake is still living, and has increased in size, although no exact growth measurements have been taken. Total length at time of writing (Jan. 10, 1953) is 992 mm.; tail length, 130 mm.; girth at midbody, 69 mm.; head length, 24.6 mm.; head width, 14.9 mm.; scale rows, 21-21-19; ventrals, 201; subcaudals, 57; supralabials, 7-7; infralabials, 8-9; preoculars, 1-1; postoculars, 2-2; temporals, 2-3; 22 yellowish-white annuli on body, 6 on tail.

The pattern of the present specimen differs from H. M. Smith's (1942) diagnosis of *annulata* in a number of ways: (1) The snout has whitish marks on the rostral, internasals, in the preocular region, and on the first 4 supralabials. (2) The red bands are not excessively broad (first red band longest—6 scale lengths, average 2½ scale lengths), and three sets of black rings are confluent across the red areas dorsally. (3) The black areas of the ventrum are only slightly broader than the intervening white areas.

Blanchard (1921), on the other hand, mentions the above numbered pattern characteristics in his diagnosis of *annulata,* but states that these characteristics are found in specimens from a more northerly portion (Brownsville region) of the range. Apparently Blanchard is here hinting at intergradation between *annulata* and *gentilis,* for a few paragraphs later he states that *annulata* differs from *gentilis* "(1) in having the

snout nearly or entirely black instead of lightened on the end; (2) in having the white rings of about the same width on sides and belly as on the middorsal line, instead of widened there; (3) in having the belly marked with broad areas of black and white; and (4) in having a distinctly higher average number of ventral plates." It should be noted then, that our specimen, which disagrees to a limited extent with all of Blanchard's points, would actually be more like *gentilis* than *annulata.* This fact becomes even more apparent when our specimen very easily keys to *gentilis* (has 28 white annuli, see Plate I) in Perkins (1949) and Schmidt and Davis (1941).

An *annulata* record from Kerr County, Texas reported by Mulaik and Mulaik (1943) further complicates the situation, for Kerr County is about 175 miles north of Hebbronville, and in a direction toward typical *gentilis* territory. We thus have specimens with *annulata* characteristics on opposite sides of an area in which a specimen with *gentilis* characters occurs. There is a possibility that the single specimen herein reported is actually aberrant, and in such a case should not merit special notice. We prefer, therefore, to tentatively allocate our specimen to the status of an intergrade between *annulata* and *gentilis* pending further studies with more material.

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The Lined Snake, *Tropidoclonion lineatum* (Hallowell)

By L. W. RAMSEY

The first published description of the lined snake was by Dr. Edw. Hallowell in 1856. The single specimen from "Kansas," presented to the Academy of Natural Sciences of Philadelphia by Dr. Hammond, was described by Hallowell as *Microps lineatus*. Cope, in 1860, found that the generic name was preoccupied and proposed the name *Tropidoclonion*. Later, Cope (1900) referred to the form as *Tropidoclonium lineatum*. Dunn (1932) proposed referral of this form to *Thamnophis*. Taylor (1942), in showing that *Tropidoclonion lineatum* was not congeneric with *Adelophis, Ischnognathus,* or *Storeria,* pointed out that apical scale pits were present in *Tropidoclonion*. This fact had evidently been overlooked by earlier herpetologists. Taylor regarded the genus as monotypic.

Force (1930) commented that *Tropidoclonion lineatum* was the most abundant small snake in the vicinity of Tulsa, Oklahoma, and she later (1931) described some habits and the birth of young of this form. In 1935 she studied the relation of knobbed anal keels to age and sex for this species. Ramsey (1946) discussed a fall mating of two captives and in 1947 he discussed the feeding behavior of certain captives. Hamilton (1947) found seven individuals hibernating at a depth of 6 to 8 inches at Dallas, Texas, and he suggested the possibility that the form might be somewhat communal in its hibernating behavior. Brumwell (1951) reported finding two individuals on the Fort Leavenworth, Kansas, military reservation. One, found in May, was 18 inches below the surface in a damp, rocky meadow, and the other was found in a damp forest. He reported that earthworms were numerous at both situations.

The genus *Tropidoclonion* Cope appears to be sufficiently distinct to warrant its retention. The entire anal plate (it is very rarely divided) distinguishes it from *Natrix,* the presence of scale pits distinguishes it from *Thamnophis,* and the peculiar hemipenial papilla, or "awn," distinguishes it from both. Moreover, as will be pointed out later, *Tropidoclonion* appears to have had a somewhat different evolutionary history from either *Natrix* or *Thamnophis* and cannot have been derived from any presently existing form of either.

As with many highly specialized forms, the range of *Tropidoclonion* appears to be spotty, probably discontinuous, indicating that at one time it was more extensive than at present. Some of the older locality records are almost certainly in error. Conant (1938) has discredited the Hughes, Butler Co., Ohio, record, and Dunn (1932) has indicated that Stone's specimen from Clinton Co., Pennsylvania, has been lost. The locality given for U. S. Nat Mus. No. 56030 as Sherwood, Franklin County, Tennessee, is also regarded with doubt. It is remote from any other records for the species. Dr. Doris M. Cochran has informed me that this specimen, along with some 5000 other specimens, was given to the United States National Museum by the estate of Julius Hurter, but that Hurter's original catalogues and correspondence were never made available to the museum. There is thus no way by which to check upon the source of this specimen. It appears, therefore, that with the exception of the state of Illinois, there are no acceptable records of *Tropidoclonion lineatum* from east of the Mississippi River. Dellinger and Black (1938) list an indi-

vidual from Imboden, Arkansas. This record is regarded as doubtful until the collection of more specimens from that vicinity confirms that a population of the lined snake actually exists there.

Maslin (1950) has reported *Tropidoclonion lineatum* from Denver, Colorado and from near Higbee, Colorado. Blair (1950) reported the species from the western part of the Oklahoma panhandle. In a letter, Dr. Blair has informed me that these specimens were not preserved and therefore are not available for study. It is very likely that these records mark the western limit of the range of the species. There is a wide gap between these localities and any others, however, and it may well be that they represent one or more isolated populations.

Unfortunately, the locality from which Dr. Hammond obtained the single specimen which forms the type for the species and genus is unknown. Indeed, some question can be raised as to the identity of the person who sent the specimen to the Academy of Natural Sciences. Between 1850 and October 21, 1856, the date on which Hallowell's description was received for publication by the Academy, two assistant surgeons of the United States Army, Dr. John Fox Hammond and Dr. William Alexander Hammond, were collecting in the west (Hume, 1942). Dr. John Fox Hammond was in California, so he could have had nothing to do with the specimen sent from "Kansas." Dr. William Alexander Hammond was, however, in Kansas, having been stationed at Fort Riley part of the time. Other places he is known to have visited during the above interim are Fort Leavenworth, Kansas, and Fort Kearney, Nebraska. It seems likely, therefore, that Dr. William Alexander Hammond was the one who sent the specimen to the Academy and, since the specimen is listed as being from "Kansas," it probably came from northeastern Kansas, either from the vicinity of Fort Leavenworth or of Fort Riley. Correspondence with Dr. E. R. Dunn has indicated that there is nothing further in the files of the Academy, such as dates, names of other collectors, etc., which would tend to help fix the locality more definitely. Dr. Dunn did indicate, however, that Dr. Hammond sent a great many specimens to the Academy between 1850 and 1860, and that many of them were listed as actually being from Fort Riley, or else a mileage from Fort Riley was given.

As to the specimen itself, Mr. Roger Conant very kindly examined it for me. He reported that the specimen was listed in the Academy's files as *Thamnophis lineatus* and that it was a female having 34 caudals and 139 ventrals. The ventral count was one greater than that given by Hallowell, but this agrees closely enough since it is not certain just where Hallowell began his count in the neck region. There is little doubt that the specimen is actually the holotype for *Tropidoclonion lineatum*. There is no significant difference in the caudal counts of specimens from various sections of northeastern Kansas, but there are differences in the ventral counts. Unfortunately, the series of specimens available from the area was not large enough to be entirely satisfactory, and no specimens were available from Geary County, Kansas, or from the immediate vicinity of Fort Riley. Moreover, as will be pointed out later, Fort Riley falls within an area in which two subspecies probably intergrade. With the exception of a single female having 138 ventrals from Dickinson Co., Kansas, there appears to be a gradient towards reduction in ventrals for females from Pottawatomie and Wabaunsee counties eastward to Kansas City. The ventral count for females from Pottawatomie and Wabaunsee counties

ranges from 141 to 147, mean 144.1. For Leavenworth Co., the ventrals range from 140 to 145, mean 142.7. For Douglas Co., the range is 135 to 144, mean 140.7, and for Kansas City, Mo., the range is 138 to 141, mean 140. Hallowell's type with 138 ventrals (or 139, as given by Conant) appears to fit in better with specimens from the more eastern counties of Kansas. Accordingly, it is classified with the population of *Tropidoclonion lineatum* that ranges over the extreme northeastern section of Kansas.

For the information that follows pertaining to the itinerary of Dr. William Alexander Hammond I am indebted to Mr. W. R. Taylor, of the Museum of Zoology, the University of Michigan. From April 7 to June 22, 1854, Dr. Hammond was traveling from Fort Leavenworth, to Fort Riley, Kansas; he was stationed at Fort Riley from June 22, 1854 until May 23, 1855, when he went to Fort Leavenworth, remaining there until August 21, 1855. On the latter date he joined the Sioux Expedition to Fort Kearney, Nebraska, after which he returned to Fort Riley. Fort Riley undoubtedly served as a shipping point for specimens collected by Dr. Hammond (and possibly by others also) over a rather large area.

Since it is known that Dr. Hammond was in Fort Leavenworth at least twice within a reasonable period of time prior to the date when Hallowell's description of *Microps lineatus* was given to the Academy for publication, and since the type specimen itself agrees more nearly with others from extreme northeastern Kansas, it seems reasonable to suppose that it probably came from the Fort Leavenworth area.

Up to the present time, no study of the geographic variation in this form has been undertaken. In the present study I have examined 439 specimens from various parts of the range of the species. The pattern, throughout the entire range, is remarkably constant, but an analysis of the scale counts indicates that at least three well-differentiated subspecies are involved. Since not all specimens recorded have been traced and examined, and since all the literature on this species has not been readily available, I have not attempted to make this study strictly monographic. In the interest of brevity conventional synonymies and lists of specimens examined have been omitted. Only information directly pertinent to the present study is incorporated. The raw data, not here presented, are available upon request to the author. All scale counts were made in accordance with Schmidt and Davis, Field Book of Snakes, page 26. For those who do not include the terminal spine in the caudal count, the caudal counts given here should be reduced by one.

Tropidoclonion lineatum lineatum (Hallowell)

Holotype. Academy of Natural Sciences of Philadelphia number 5922, a female. Reported by Dr. E. R. Dunn to be in fairly good condition, although faded. The type locality is hereby restricted to the vicinity of Fort Leavenworth, Kansas.

Diagnosis. This subspecies is characterized by a relatively high number of caudals, but with a reduction in the number of ventrals. Ventrals usually fewer than 144 in females, and fewer than 143 in males. Caudals usually more than 32 in females and more than 40 in males.

General description. The pattern consists of three light stripes on a grayish (in alcohol) or brownish background. The middorsal light stripe occupies the vertebral row and half of each adjoining row. It extends from the back of the head onto the tail, and is bordered by a row of small black spots on each side, the spots being variable in size, sometimes

large enough to appear as a black line bordering the light stripe. A lateral light stripe, about one scale wide, is situated on the second and third lateral scale rows. It is also bordered above and below by a series of small black spots, the spots sometimes being large enough to appear as a line. The dark color of the first lateral row sometimes encroaches slightly on the ends of the ventrals. The venter is plain white except for a double row of large half-moon-shaped black spots on the anterior half of each ventral. This series of spots continues on under the tail. The two rows of spots are fused in the neck region, sometimes for the entire length of the snake, but are usually distinct on the body, being somewhat closer together than to the ends of the ventrals. The head is uniform (sometimes slightly mottled) gray or brown. Both upper and lower labials are white, with some darkening along the upper edges of the upper labials.

The dorsal scales are keeled, except for the first row, which is usually smooth or keeled only near the anus. They are bipunctate with two very small pits near the apex, one on each side of the ridge. The head plates are normal. The nasal is entire, with the nostril in the upper anterior portion and a very shallow groove below it. This groove is sometimes incomplete, and occasionally absent. The loreal is slightly longer than high and there are two postoculars and one preocular. Only one temporal is in contact with the postoculars and characteristically the lower secondary temporal is large and wedged between the fifth and sixth upper labials. The posterior genials are much shorter than the anterior pair.

Variation in females. The supralabials are 6-7 or 7-6 in 9.1%, 6-6 in 54.5%, 5-6 or 6-5 in 6.1%, and 5-5 in 30.3% of the specimens. The third and fourth supralabials enter the eye, and reduction is usually accomplished by the fusion of these two, although in a few cases the second and third or more rarely the second and first are fused. The infralabials are 7-7 in 3.3%, 7-6 or 6-7 in 10%, 6-6 in 80%, 5-6 or 6-5 in 3.3%, and 5-5 in 3.3% of the specimens.

The dorsal scale count is most frequently 17-19-17, the maximum count being 19 in 93.8%, 18 in 3.1%, and 17 in 3.1% of the specimens. The preanal dorsal count is 17 in 85% and 15 in 15% of the specimens. The dorsal count increases from 17 to 19 by the addition of a fourth lateral row, this same row being dropped posteriorly. This interpolated fourth row is quite variable in length. In some individuals it is very long and in others quite short, consisting in some cases of only a few scattered scales or even being omitted entirely.

Ventrals: range 135 to 148, mean 141.2, standard deviation 2.73. Most of the specimens have a ventral count less than 144, and this character separates 81.3% of *lineatum* from the subspecies next to be described.

Caudals: range 31 to 40, mean 34.6, standard deviation 2.52. This lies within the range for the subspecies being described next, but is higher than for the population in Texas (79.4% of the specimens have a caudal count of more than 32).

Nothing was gained in distinction by taking the sum of the ventrals and caudals. However, the sum of these two counts ranges from 169 to 184, with a mean of 175.5 and a standard deviation of 3.96. The sum is less than 178 for 72.4% of the specimens. The tail-to-total-length ratio ranges from .119 to .204, mean .136. This hardly gives a true picture, however, as for all but three of the group the range is from .124 to .153.

The total number of females examined was 35.

Variation in males. Supralabials 6-6 in 61.4%, 5-6 or 6-5 in 22.5%, and 5-5 in 16.1% of the specimens. The manner of reduction is the same as for the females. Infralabials 6-7 or 7-6 for 3.2%, 6-6 for 87.1%, 5-6 or 6-5 for 3.2%, and 5-5 for 6.5% of the specimens.

The dorsal scale formula is usually 17-19-17, the maximum count being 19 in 93.5%, 18 in 3.2%, and 17 in 3.2% of the specimens. The preanal dorsal count is 17 for 66.7%, 16 for 6.7%, and 15 for 26.6% of the specimens. As with the females, a fourth row was interpolated and the same remarks apply here.

Ventrals: range 135 to 148, mean 139.2, standard deviation 2.68. The ventrals are fewer than 143 for 93.6% of the specimens and this character was chosen to separate *lineatum* from the subspecies to be described next.

Caudals: range 34 to 47, mean 42.3, standard deviation 2.36. This differs little from the subspecies ranging immediately to the south, but is higher than for the population in Texas. The caudal count is higher than 40 for 89.3% of the specimens.

Again, nothing was gained in distinction by taking the sum of the ventrals and caudals. However, the range for this sum is 175 to 190, mean 181.3, standard deviation 3.21. This sum is lower than 185 for 85.9% of the specimens. The tail-to-total-length ratio ranges from .129 to .191, mean .172. Again, this does not give an accurate picture as for all but two of the specimens this range is .147 to .178.

The total number of males examined was 32.

Sexual dimorphism. No difference in color or pattern was apparent between the sexes. Both labial counts are more frequently 6-6 for males than for females, but the difference is slight. The preanal dorsal count is less than 17 for males with slightly greater frequency than for females. There is a slight average difference in ventrals, the mean for males being 139.2 and for females 141.2. The number of caudals, however, is quite different between the two sexes. For males the range is 34 to 47, mean 42.3, with 96.9% having 40 or more. For females the range is 31 to 40, mean 34.6, with 96.6% having fewer than 40. The males probably are somewhat smaller than females.

Intergradation. Intergradation with the subspecies to the south will be discussed under that form.

Range. Extreme northeastern Kansas, from Miami, Douglas, and Osage counties northward and eastward, eastern Nebraska, extreme southeastern South Dakota, southern Iowa, northwestern Missouri, northeastern Missouri, and central Illinois. No specimens were examined from Nebraska or from South Dakota. Hudson (1942) remarked that the lined snake was widely distributed over the eastern part of Nebraska, but that few specimens were taken. The scale counts given by him were not broken down according to sex and it is difficult to classify them. That population is for the present referred to *lineatum*. Over (1943) lists the species from Clay and Minnehaha counties of South Dakota. The species appears to be completely absent from central Missouri and from extreme southern Illinois. The population of the lined snake in central Illinois is referred to *lineatum* for the present, although it may have become sufficiently differentiated to be distinguishable from *lineatum*. This, however, is the subject of investigation by another person. The southern limit of the range of this subspecies in Kansas is not greatly different from the southern limit of Pleistocene glaciation.

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The data given by Maslin (1950) for his specimens from Colorado indicate that in ventral and caudal counts the Colorado population differs little, if any, from typical *lineatum*. There may be some differences, of which I am not aware, but for the present at least this population is considered as *lineatum*, even though it is geographically remote from any other known population of that form. Grobman (1941) encountered a similar situation in the distribution of *Opheodrys vernalis blanchardi*. He found this subspecies to range northward and eastward from the southern limit of Pleistocene glaciation slightly northwestward into the Great Plains of Nebraska, and into the Rocky Mountains system of Colorado, New Mexico, Wyoming, and Utah. He had no records from western Kansas or from western Nebraska. In Kansas and Nebraska the ranges of *Tropidoclonion l. lineatum* and *Opheodrys v. blanchardi* are almost coincident, if I am correct in assigning the eastern Nebraska population of the lined snake to *Tropidoclonion l. lineatum*.

Habits and habitat. Very little information has been available regarding habits or habitat. Presumably they are not greatly different from those of the other subspecies. The habitat seems to be the glaciated prairie region from Kansas and Nebraska, on into Illinois.

Tropidoclonion lineatum annectens new subspecies

Holotype. University of Kansas Museum of Natural History number 30005, a female collected by Harold Dundee May 3, 1951, at Tulsa, Oklahoma.

Paratypes. Females: University of Kansas Museum of Natural History numbers 30006, 30007, and 30011. Males: University of Kansas Museum of Natural History numbers 30008, 30009, and 30010. All were collected by Harold Dundee May 3, 1951, at Tulsa, Oklahoma.

Diagnosis. This subspecies is characterized by having relatively high ventral and caudal counts. Ventrals usually more than 143 for females, and more than 142 for males. Caudals usually more than 33 for females and more than 40 for males. The sum of ventrals and caudals is usually more than 177 for females and more than 184 for males.

Description of holotype. Ventrals 149; caudals 35, in double series; anal entire; dorsal scale formula 17-19-17. All scales keeled except first lateral row, which is enlarged and smooth. Supralabials 6-6, the third and fourth entering the eyes; infralabials 6-6; preoculars 1; postoculars 2; loreal somewhat longer than high; nasals entire, with a groove below each nostril; one temporal in contact with postoculars; secondary temporals 2-3; postgenials much smaller than pregenials. Total length 281 mm.; length of tail 38 mm.

Venter plain white, except for a double series of prominent half-moon-shaped black spots on anterior half of each ventral. The double series continues on the subcaudals to the end of the tail. First lateral scale row light gray with a black spot at the base of each scale. The dark color encroaches very slightly on the ends of the ventrals. Second lateral row light gray with a black spot on the lower half of each scale. Third lateral scale row light gray with upper half of scale darker than lower half. The second and third scale rows thus outline a lateral light stripe which is confined to those two rows. Fourth and fifth rows darker gray, usually with a small black spot at the base of each scale. The middorsal light stripe occupies the vertebral scale row and half of each adjoining row. It is bordered on each side by two rows of dark gray, with a black spot at the base of each scale. Top of head unicolor gray; labials white

except for slight darkening of upper edges of upper labials. Head somewhat pointed; practically no neck constriction.

Variation among paratypes. Ventrals in females 145-148, mean 146.7; in males 140-149, mean 145.3. Caudals in females 33-37, one tail incomplete; in males 42-46, mean 44.7. Supralabials: females 6-6 for two specimens, 6-5 for one due to third and fourth being fused; males 6-6. Infralabials: females 6-6 for one, 6-5 for one, with second and third fused, one damaged; males 6-6 for two, 6-7 for one specimen. Nasals grooved below nostril for three specimens, ungrooved for three. First lateral row keeled near anus for two specimens (1 male and 1 female). Dorsal scale formula 17-19-17 for five specimens, 17-18-17-15 for one. In the latter individual the interpolated fourth row consists only of a few scattered scales on each side. It is possible to count 18 at a few points on the body, 19 nowhere, although the specimen actually is a 19-rowed snake. Color and pattern: same as for holotype except that for one specimen the lateral stripe is more prominent, being lighter and also because the black spots that border it are larger. For one individual the majority of ventral spots are fused.

Variation in females. Supralabials 7-7 for 0.9%, 6.6 for 60.6%, 5-6 or 6-5 for 17.9%, 5-5 for 19.7%, and 4-5 for 0.9% of the specimens. Infralabials 7-7 for 4.3%, 6-7 or 7-6 for 7.8%, 6-6 for 85.4%, 5-6 or 6-5 for 1.8%, and 5-5 for 0.9% of the specimens. Dorsal scale formula usually 17-19-17; maximum dorsal count 19 for 91.5%, 18 for 1.7%, 17 for 6.8% of the specimens. Preanal dorsal count 17 for 86.6%, 16 for 3.5% and 15 for 8.9% of the specimens. Ventrals: range 142 to 156, mean 147.0, standard deviation 2.54. Ventrals are 144 or more for 94% of the specimens, and 145 or more for 78.6% of them. Caudals: range 24-39, mean 34.3, standard deviation 1.93. Caudals are 34 or more for 74.3% of the specimens. Ventrals plus caudals: range 168-189, mean 181.8, standard deviation 3.2. Ventrals plus caudals are 178 or more for 88.6% of the specimens. The ratio of length of tail to total length ranges from .105 to .152, mean .130. For all but three specimens the range is .113 to .146. The color was usually gray or grayish olive, sometimes brown or yellowish brown. The number of females examined was 118.

Variation in males. Supralabials 6-6 for 72.8%, 5-6 or 6-5 for 17.1%, and 5-5 for 10.2% of the specimens. Infralabials 7-7 for 2.2%, 6-7 or 7-6 for 9%, 6-6 for 81%, 5-6 or 6-5 for 6.7%, and 5-5 for 1.1% of the specimens. The dorsal scale formula is most frequently 17-19-17, but variations from this are fairly common. Maximum dorsal count 19 for 76.8%, 18 for 10.4%, and 17 for 11.7% of the specimens. Preanal dorsal count 17 for 55.3%, 16 for 1.2%, and 15 for 43.5% of the specimens. Ventrals: range 139-153, mean 145.4, standard deviation 3.00. Ventral count 143 or more for 87% and 144 or more for 70.7% of the specimens. Caudals: range: 36-47, mean 42.4, standard deviation 2.38. Caudals are 41 or more for 81.3% of the specimens. Ventrals plus caudals are 179-196, mean 187.8, standard deviation 4.02. This sum is 185 or more for 82.2% of the specimens. The tail-to-total-length ratio ranges from .131 to .191, with all but three specimens ranging .143 to .176. The mean is .158. The color is gray or grayish olive, sometimes brown or yellowish brown. The total number of males examined was 92.

For specimens from Cowley Co., Kansas, the supralabial count was less than 6-6 more frequently than for specimens from any other area.

Sexual dimorphism. As with *lineatum*, there is no apparent difference in pattern or color between the sexes. The supralabials are more often 6-6 for males but the infralabials are 6-6 with slightly greater frequency for females. There is a slight average difference in the number of ventrals. The ventral count averages 145.4 for males, 147 for females. Considerable difference is exhibited in the number of caudals, however. The caudals for males average 42.5, range 36-47, with 93.7% of them having 39 or more. The caudals for females average 34.3, range 24-39, with 98.1% of them having fewer than 39. Force (1935) has already discussed the relation of knobbed anal keels to sex for the species and most, if not all, of her material was *annectens*. The males appear to be somewhat smaller than the females.

Intergradation. Intergradation between *annectens* and the Texan subspecies will be discussed under that form. A series of 26 specimens suspected of being *annectens-lineatum* intergrades was available. This, of course, is not sufficient to determine with any great accuracy the area in which these two subspecies intergrade. Specimens from Anderson, Greenwood, Sedgwick, and Cowley counties are classed as *annectens*, since they have relatively high ventral counts. Similarly, specimens from Miami, Douglas, Osage, and Shawnee counties are classed as *lineatum*. Intergradation is to be expected to occur in the region between these two groups of counties. For Dickinson Co., a single female with 138 ventrals classes as *lineatum*, but 5 of 7 males class as *annectens*. From northeastern Pottawatomie Co., 2 females and 4 males classify as *annectens*, whereas 5 other males from the same localities classify as *lineatum*. From Wabaunsee Co., two individuals classify respectively as *annectens* and *lineatum*. Specimens from Dickinson, Pottawatomie, and Wabaunsee counties are thus regarded as intergrades. It is entirely possible that when more specimens from this area become available, *annectens* and *lineatum* may be found to intergrade in Miami and Anderson counties and possibly also in part of Osage and Shawnee counties. Present data do not support this conjecture, but the number of specimens available from these four counties is so small that any conclusion now made may well be inconclusive. The region of intergradation thus outlined would roughly include the southern limit of Pleistocene glaciation.

Range. The range of this subspecies is indefinite, due to the paucity or complete lack of specimens in the series examined from some areas which seem to be within its range. There were no specimens from western Kansas or Nebraska, very few from southern Oklahoma, or from the drainage system of the Red River in Texas. There were also none from southwestern Missouri or from northwestern Arkansas. The range appears to be southeastern Kansas from Sedgwick, Greenwood, and Anderson counties southwards and eastwards, Oklahoma eastward from Kay, Noble, Logan, and Comanche counties, and southward into Texas, probably including a strip of north Texas averaging 75 to 100 miles south of the Red River. It is to be expected from extreme southwestern Missouri and northwestern Arkansas, but no records were available from these areas.

Habits and habitat. Little information is available. Force (1931) discussed some habits, evidently of this subspecies. She also found specimens feeding on earthworms. Probably the habits are little different from those of the other subspecies. The habitat seems to be the open prairie.

Tropidoclonion lineatum texanum new subspecies

Holotype. Texas Natural History Collection, University of Texas,

number 262, collected on F. W. Allen ranch 13 miles south of Bertram, Burnet Co., Texas, April 14, 1947, by W. F. Blair.

Paratypes. All in Texas Natural History Collection, and collected on F. W. Allen ranch, 13 miles north of Bertram, Burnet Co., Texas, by Alvin Flury. Females: numbers 4797 collected March 30, 1941, 4798 collected in October 1941, and 4806 collected April 20, 1947. Males: number 4803, collected April 4, 1947, numbers 4804 and 4805 collected April 20, 1947.

Diagnosis. This subspecies is characterized by having a reduced number of caudals and ventrals. Caudals: females with fewer than 34, males with fewer than 41. Ventrals: females with fewer than 145, males with fewer than 144. Ventrals plus caudals: females with fewer than 178, males with fewer than 185.

Description of holotype. A female having 140 ventrals and 30 caudals. Caudals in double series. Anal entire: dorsal scales 17-19-17. All scales keeled except first lateral row which is enlarged and smooth. Supralabials 6-6, the fifth being largest, third and fourth contacting the eyes. Infralabials 6-6. Preoculars 1; postoculars 2; loreal somewhat longer than high. Nasals entire, grooved below nostril. One temporal in contact with postoculars, secondary temporals 2-2. Postgenials smaller than pregenials. Total length 315 mm.; length of tail 39 mm. Pattern as in holotype of *annectens* except that dark pigment of first lateral row does not encroach on lateral edges of ventrals.

Variation among paratypes. Females: ventrals 141-143, mean 142. Caudals 29 and 33, one tail incomplete. Supralabials and infralabials all 6-6. Nasals grooved in two specimens, not grooved in one. Dorsal scales 17-19-17 for two, 17-17-15 for one. One individual with no dark color on lateral edges of ventrals.

Males: ventrals 139-142, mean 140.7; caudals 36-39, mean 37.3. Supralabials 6-6 for two, 5-5 for one individual. Infralabials 6-6 for two, 6-7 for one. One with caudals 2-4 entire, one with caudals 2-5 entire. Nasals grooved for two, ungrooved for one. Dorsal scales 17-19-17 for one, 17-18-17-15 for two. One with no lateral dark color on edges of ventrals.

Variation in females: supralabials 6-7 or 7-6 for 1.8%, 6-6 for 89.2%, and 5-6 or 6-5 for 9.0% of the specimens. Infralabials 7-7 for 7.1%, 6-7 or 7-6 for 1.8%, 6-6 for 82.3%, and 5-6 or 6-5 for 8.8% of the specimens. Dorsal scales most frequently 17-19-17; maximum dorsal count 19 for 80% of the specimens; preanal dorsal count 17 for 67.3%, 16 for 10.9%, and 15 for 21.8% of the specimens. Ventrals range 136-148, mean 142.0, standard deviation 2.89. The ventrals are fewer than 145 for 85.5% for the specimens. Caudals range 25-36, mean 31.4, standard deviation 2.16. The caudals are fewer than 34 for 86.3% of the specimens. Sum of ventrals and caudals range 161-182, mean 173.0, standard deviation 4.04. Ventrals plus caudals are fewer than 178 for 90.2% of the specimens. This character gives a better separation between *annectens* and *texanum* than either the ventral or caudal count alone. The ratio of tail to total length ranges from .110 to .148, mean .127. A gradual trend toward reduction in both ventrals and caudals toward the south was noted. The number of females examined was 55.

Variation in males: supralabials 6-6 for 93.3% of the specimens and 5-5 for 6.7% of them. Infralabials 6-7 or 7-6 for 7.6%, 6-6 for 84.7%, 5-6 or 6-5 for 2.6%, and 4-5 or 5-4 for 5-1% of the specimens. Dorsal

scales most frequently 17-19-17-15. The maximum dorsal scale count is 19 for 62.9% of the specimens. The preanal dorsals are 17 for only 27.3% of the specimens, but 15 for 63.6% of them. Ventrals range 132-150, mean 139.9, standard deviation 4.41. Ventrals fewer than 144 for 79.6% of the specimens. Caudals range 34-45, mean 38.9, standard deviation 2.56. The caudals are fewer than 41 for 77% of the specimens. Sum of ventrals and caudals range 166-190, mean 178.7, standard deviation 5.25. Ventrals plus caudals are fewer than 185 for 82.1% of the specimens. This character gives slightly better separation from *annectens* than either ventrals or caudals alone. The tail-to-total-length ratio ranges from .133 to .203, with all but two specimens ranging from .140 to .172. The mean is .156. A gradual trend towards reduction of ventrals and caudals to the southward was noted. The number of males examined was 44.

Sexual dimorphism. As with the other two subspecies, there is no difference in pattern between the two sexes. Both infralabials and supralabials are slightly more frequently 6-6 for males than for females. The dorsal count is more frequently less than 19 for males than for females, and the preanal dorsals are much more frequently less than 17 for males than for females. The preanal dorsals drop to 15 for 63.6% of the males. This would indicate that males tend to be more slender and less tapering than females. There is no average difference in ventrals, the mean for males being 139.9, for females 142.0. The caudal count shows the greatest difference between the sexes. The mean caudal count is 38.9 for males, with 94% having 36 or more. For females the mean caudal count is 31.4, with 96.1% having fewer than 36. The males are also probably smaller in size.

Intergradation. A total of 37 specimens, including 24 from Tarrant and Dallas counties, suspected of being intergrades, were examined. The caudal count of Tarrant and Dallas Co. females is typical of *texanum;* the ventral count is high, however, more typical of *annectens.* The sum of ventrals and caudals is also high, and would classify most of the females as *annectens.* The caudal count of the males from Tarrant and Dallas counties is intermediate between *texanum* and *annectens,* and would classify exactly half of the males with each subspecies. The ventral count and sum of ventrals and caudals are both low and would classify most of the males as *texanum.* There is thus little doubt that *annectens* and *texanum* intergrade in Tarrant and Dallas counties in Texas. For a smaller series (10 specimens) from Palo Pinto Co., the caudal and ventral counts classify the majority of females as *texanum* and the majority of males as *annectens.* These must also be intergrades. Three specimens (1 male, 2 females) from Van Zandt Co., Texas, are all *annectens.* A single specimen from Archer Co. is *texanum.* These data are insufficient to determine accurately the entire area of intergradation. However, it seems probable that intergradation occurs along a line extending southeastward from Archer Co., through Palo Pinto, Tarrant, and Dallas counties, and south of Van Zandt Co. The absence of material from areas between Tarrant and McLennan counties on the south and between Tarrant Co. and the Red River on the north leaves the width of the region of intergradation completely in doubt. It is assumed to be rather wide, however, since the McLennan Co. population of *texanum* shows a strong tendency toward increase in the number of ventrals and caudals.

Range. The Texan subspecies of the lined snake ranges southward

from the area of intergradation to the Gulf of Mexico, eastward to Waller Co., and westward to Kerr, Concho, and Coke counties. In addition to the counties from which I have examined specimens, Brown (1950) lists the species from Cass, Hays, Marion, Victoria, Williamson, and Wise counties of Texas. With the possible exception of Cass, Marion, and Wise counties, these are all localities for *texanum*. The subspecific status of the Cass, Marion, and Wise county specimens is at present unknown, but they are more likely *annectens* or possibly intergrades. *Tropidoclonion l. texanum* appears to be more abundant along the Balcones escarpment region from San Antonio through Austin to Waco, Texas.

Habitat. The lined snake in Texas seems to prefer the open prairie or sparsely timbered flats, where the soil is of limestone origin, and where there are slabs of limestone under which it may hide. In such places it is seldom found under any other type of cover. Here, earthworms are numerous, and the lined snake is often found in association with *Sonora e. episcopa* and occasionally with *Haldea striatula*. I have collected all three species from under the same rock. Apparently, the lined snake avoids the deep woods and and marshy or boggy places. The type of habitat which it seems to prefer is most frequently encountered in the eastern part of the Edwards Plateau of Texas, eastward somewhat beyond the Balcones escarpment and northward to the Red River. Over most of this region the annual rainfall is from 25 to 40 inches. There are a few records of the lined snake from the timber belt of east Texas and from the Gulf coast, but it seems doubtful that the snake occurs generally over such regions.

The lined snake seems to be more common in some urban areas than in non-urban ones. In urban areas most, if not all, of the natural cover has been removed by man. In such places the snake finds concealment under sidewalks, boards, foundations, or practically anything that is available. It is very frequently found under leaves or debris in flower beds.

Habits. Observations upon habits are based upon the intergrading population of Tarrant Co., Texas. The lined snake seems to be nocturnal during the summer, crepuscular during the spring and fall. I have observed individuals abroad before sunset, and have seen a few individuals sunning themselves in the early morning sun. In the summer I have found a few individuals prowling at night, one feeding upon an earthworm.

The lined snake hibernates from November until March, but may come out during warm spells of the winter months. I have collected specimens during every month of the year, but the snake seems to reach its greatest abundance during April. In urban areas, hibernation takes place under whatever cover may be available, or the snake may burrow underground if the soil is loose or soft. In natural areas it probably hibernates in holes under rocks where it lives most of the year.

The diet consists almost entirely of earthworms. Captives will eat nothing else. The very few records available of stomach contents showed that only earthworms had been ingested. Curtis (1949) records finding a specimen that was eating a "sowbug." Cannibalism is rare among captives and probably does not occur at all in nature. Other ophiophagous snakes, certain birds, and some mammals probably are natural enemies of the lined snake. Very likely racers, whipsnakes, and king snakes, which are frequently found in the same habitat as the lined snake, are its worst natural enemies. In many urban areas the lined snake appears to be much

more common than in adjacent natural areas, despite the fact that most people kill the snakes whenever found. During one spring month I counted more than forty dead lined snakes lying on the sidewalks within a few blocks of Texas Christian University.

The young are born alive in August, the number varying from 3 to 12, averaging about 6. This agrees with Force's (*loc. cit.*) statement for Oklahoma specimens. The young are from 4 to 4¾ inches long at birth. Curtis (1949) observed a pair mating in October. A pair of my captives mated while in captivity on Sept. 1 (Ramsey, *loc. cit.*). A male, captured in October, and immediately caged with a female, began courting her about an hour after being placed in the cage. Mating did not take place, although the male was observed to persist in his attentions for more than an hour. The captive female that was observed to mate Sept. 1 was caged separately from males thereafter. She gave birth to three the following August. The evidence indicates that, at least in Texas, the lined snake may mate in the fall. It seems certain that at least some individuals do. I have seen no evidence of mating in the spring.

COMPARISONS AND RELATIONSHIPS

Figures 1 to 3 show graphically the variation in ventrals, caudals, and

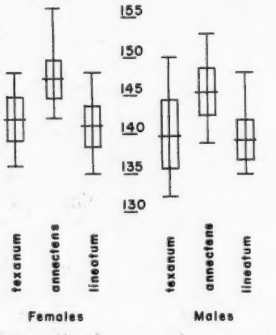

Figure 1. Plot of ventral count.

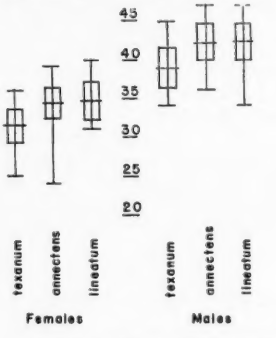

Figure 2. Plot of caudal count.

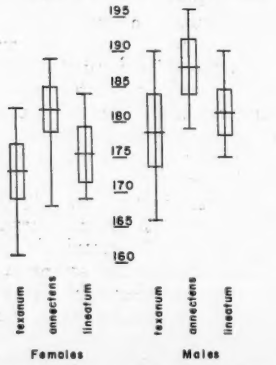

Fig. 3. Plot of ventrals and caudals.

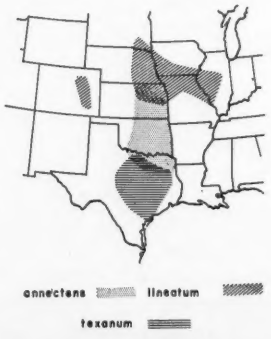

Fig. 4. Range of subspecies of Tropidoclonion lineatum.

ventrals plus caudals for each subspecies and for both sexes. Each plot shows the range and the mean for the character indicated, and the range for one standard deviation on either side of the mean. Figure 4 shows the geographic range for each subspecies, as now understood.

It is difficult to analyze size data. The largest individual examined was a female of *annectens* 422 mm. in total length. Another *annectens* female was 400 mm. in total length. The largest male of *annectens* was 313 mm. long. The largest female of *texanum* was 382 mm. long, and a higher percentage of *texanum* females were large. The largest male *texanum* was 367 mm. long, but there were no others longer than 286 mm., yet the percentage of large individuals was greater than for *annectens* males. For *lineatum,* the largest female was 338 mm. long and the largest male 346 mm. This one male, however, was the only one longer than 279 mm., and the percentage of large individuals was notably less for both sexes of *lineatum* than for either of the other subspecies. It seems fairly certain that *lineatum* is the smallest of the three subspecies, but there is no great size difference, if any, between *texanum* and *annectens.* The females of each subspecies probably are larger than the males.

The following geographic gradients, or clines, were noted:

1. A tendency towards reduction in number of ventrals to the north and to the south. Highest ventral count—*annectens.* Fewer ventrals—*texanum* and *lineatum.*
2. A slight tendency towards reduction in total number of infralabials to the north and to the south.

	Females	Males
lineatum	12.05	11.87
annectens	12.10	12.08
texanum	12.01	11.90

3. A slight tendency towards reduction in total number of supralabials to the north.

	Females	Males
lineatum	11.40	11.42
annectens	11.40	11.62
texanum	11.90	11.80

4. A tendency toward reduction in size to the north. Largest—*annectens* and *texanum,* smallest—*lineatum.*
5. A tendency toward reduction in number of caudals to the south. High caudal count—*annectens* and *lineatum,* fewer caudals—*texanum.*
6. A tendency toward reduction in maximum dorsal count to the southward, this tendency being greater for males than for females.

	Females	Males
lineatum	93.8% with 19 rows	93.5% with 19 rows
annectens	91.5% with 19 rows	76.8% with 19 rows
texanum	80.0% with 19 rows	62.9% with 19 rows

7. A similar trend toward reduction in the number of preanal dorsals, again emphasized for males.

	Females	Males
lineatum	85.0% with 17 rows	66.7% with 17 rows
annectens	86.6% with 17 rows	55.3% with 17 rows
texanum	67.3% with 17 rows	27.3% with 17 rows

The first two clines indicate *annectens* to be the most primitive of the three subspecies. The tendency for the species as a whole seems to be along orthoevolutionary lines towards reduction in scutellation and possibly in size, although the reduction in size to the northward may be due to the shortened growing season. The remaining clines indicate retention of one or more primitive characters by each subspecies, and an acceleration in the reduction of one or more other characters. Thus, *lineatum* retains the following primitive characters: high caudal count, high maximum dorsal count, high preanal dorsal count, and *texanum* retains high supralabial count and larger size. The parent form, *annectens,* retains the following of the seven characters: higher ventral count, higher infralabial count, larger size, higher caudal count, and is intermediate in the remaining three characters. The Texan form appears to be the most modified of the three subspecies. The ancestral *Tropidoclonion lineatum* might well have been a 19 rowed snake with 17 preanal dorsals, 6 to 7 upper labials, possibly 7 lower labials, and with ventrals and caudals somewhat more than now found in *annectens*, as well as being slightly larger.

The small, pointed head, almost complete lack of neck constriction, the tendency to drop out certain scale rows, the elongated hemipenial papilla, and the feeding habits all indicate specialization. It is possible that *Tropidoclonion lineatum* may be somewhat more specialized than any presently existing American forms of *Natrix* or of *Thamnophis*. It must be considered as an end form that has become degenerate through specialization. It is remarkably similar in scutellation, and in some cases even in pattern, to certain forms of *Natrix* and *Thamnophis*.

Any attempt to indicate a possible origin for *Tropidoclonion* must, of necessity, be highly speculative. However, it can be pointed out that apical scale pits are present in *Tropidoclonion* and *Natrix*. These pits are quite small in *Tropidoclonion,* so small in fact that they were completely overlooked by most of the earlier herpetologists. This suggests that *Tropidoclonion* might also exhibit a trend toward reduction or elimination of scale pits, in addition to the other trends that have been mentioned. If such were the case, then it would be very unlikely that *Tropidoclonion* was derived from any living form of *Thamnophis*. A single instance of a divided anal was encountered in the 439 specimens that were examined. While it is possible that this may indicate derivation from a form having a divided anal, the present form still producing an occasional individual in which this primitive condition exists, the separation from *Natrix* would appear to be great enough in any event to preclude derivation of *Tropidoclonion* from any existing form of *Natrix*.

The best interpretation that I can offer regarding the origin of *Tropidoclonion* is this: In *Natrix, Tropidoclonion,* and *Thamnophis* we have an example of evolutionary parallelism along three lines, *Tropidoclonion* paralleling *Thamnophis* more closely than *Natrix,* but with an ancestry now obscure as well as extinct.

ACKNOWLEDGMENTS

I am greatly indebted to Dr. Hobart M. Smith, who suggested the project and who has offered many valuable suggestions and criticisms. I am also indebted to him for criticizing the manuscript before publication. Thanks are due to Dr. W. B. Davis of the Agricultural and Mechanical College of Texas, and to Dr. W. M. Winton and Dr. J. W. Forsyth of Texas Christian University for allowing me the use of the laboratories of those institutions. I am indebted to Mr. Harold Dundee for supplying the type series for *Tropidoclonion lineatum annectens,* to Dr. E. R. Dunn for information about the type for *lineatum,* and to Mr. Roger Conant for examining the type. I am indebted to Mr. W. R. Taylor and David H. Johnson for information about the travels of Dr. W. A. Hammond, to Paul Anderson, Edward H. Taylor, Philip W. Smith, Bryce C. Brown, and to many others for assistance and suggestions. Thanks are also due to the following persons and institutions for the loan of specimens: Paul Anderson, Bryce C. Brown, Lawrence Curtis, Alvin Flury, Clifford Johnson, Albert J. Kirn, Floyd E. Potter, Jr., The University of Kansas (Museum of Natural History), The A. and M. College of Texas (Texas Cooperative Wildlife Collection), The University of Texas (Texas Natural History Collection), The University of Oklahoma (Museum of Zoology), Texas Christian University, Baylor University (Strecker Museum), Smithsonian Institution (United States National Museum), Chicago Natural History Museum, Chicago Academy of Sciences, Illinois State Museum, Illinois State Natural History Survey, Oklahoma A. and M. College (Museum of Zoology).

LIST OF COUNTIES AND LOCALITIES FROM WHICH SPECIMENS WERE EXAMINED

ILLINOIS. *Putnam*—Granville. *Sangamon*—Springfield, no specific locality.

IOWA. *Polk*—Fort Des Moines, Des Moines.

KANSAS. *Anderson*—7 mi. NW Garnett, no specific locality. *Cowley*—Winfield, no specific locality. *Dickinson*—Industry, 4 mi. N. Herrington, 5 mi. N. Herrington, no specific locality. *Douglas*—Twin Mounds, Lawrence, 7 mi. NE Lawrence, no specific locality. *Greenwood*—4 mi. SW Toronto. *Leavenworth*—Fort Leavenworth. *Miami*—La Cynge. *Osage*—Long Creek, 3 mi. S. Carbondale, no specific locality. *Pottawatomie*—2 mi. S. Havensville, 4 mi. S. Onaga. *Sedgwick*—no specific locality. *Shawnee*—Berryton, 8 mi. N. Topeka, no specific locality. *Wabaunsee*—4 mi. W. Alma, 4 mi. S. Alma.

MISSOURI. *Jackson*—Kansas City, Lake Lotawana. *Jefferson*—4 mi. S. Festus. *St. Louis*—St. Louis, Maplewood, Webster Groves.

OKLAHOMA. *Carter*—no specific locality. *Comanche*—no specific locality. *Hughes*—no specific locality. *Kay*—13 mi. NE Newkirk, no specific locality. *Logan*—Williamson. *Muskogee*—no specific locality. *Noble*—Otoe Indian Reservation, 6 mi. E. Perry. *Okmulgee*—no specific locality. *Osage*—Hominy, no specific locality. *Pawnee*—no specific locality. *Payne*—Stillwater, 4 mi. S. Stillwater. *Pottawatomie*—no specific locality. *Tulsa*—Tulsa, no specific locality.

TEXAS. *Archer*—5 mi. S. SW Archer City. *Bexar*—San Antonio, no specific locality. *Bosque*—10 mi. W. Clifton. *Burnet*—13 mi. N. Bertram, 5 mi. N. Joppa. *Coke*—Fort Chadbourne. *Concho*—6 mi. W. Eden. *Dallas*—Dallas. *Kerr*—Kerrville. *McLennan*—Waco, 2 mi. E. Crawford, 1 mi. W. Crawford, 2 mi. from Waco, China Springs, 2 mi. W. China Springs, Tonkawa Creek, near Crawford, no specific locality. *Palo Pinto*—2 mi. NE Palo Pinto, 7 mi. N. Palo Pinto, 6½ mi. N. Palo Pinto. *San Saba*—San Saba. *Tarrant*—Fort Worth, Benbrook Dam, SW cor. Tarrant Co. *Travis*—Austin, north of Austin, Shoal Creek near Marshall Ford Road. *Van Zandt*—no specific locality. *Waller*—Hempstead.

KEY TO THE SUBSPECIES OF *TROPIDOCLONION*

1. Caudals in females fewer than 34; in males fewer than 41. Ventrals in females fewer than 145; in males fewer than 144. Ventrals plus caudals fewer than 178 for females; fewer than 185 for males. Range Texas.

l. texanum

Caudals in females 34 or more; in males 41 or more. Ventrals and ventrals plus caudals may or may not be as above. Range north Texas to Illinois . . . 2

2. Ventrals fewer than 144 in females, fewer than 143 in males. Range Colorado, northeastern Kansas, Missouri, Iowa, Illinois, eastern Nebraska, and southeastern South Dakota.

l. lineatum

Ventrals 144 or more in females, 143 or more in males. Ventrals plus caudals 178 or more in females, 185 or more in males. Range north Texas, Oklahoma, southern Kansas.

l. annectens

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T.C.U., FORT WORTH, TEXAS

NOTES ON FOOD HABITS OF SNAKES IN CAPTIVITY AND IN NATURE.—Eccentricities of food habits of individual adult snakes, and of young examples of many species, are well known to exist even though the food preferences of the species as a whole may be quite familiar. These eccentricities often make the feeding problem in captivity a real challenge. Two observations recently made may be of interest to others faced with recalcitrant feeders.

Nine young *Elaphe o. obsoleta* hatched from a clutch of 11 eggs consistently refused available insects, fish, horse meat and beef. Two accepted baby mice, but these were not available in sufficient quantity to satisfy all snakes. Adult laboratory mice were available in quantity, however, and a device for their use as food for small snakes was eventually discovered. The hind legs were disjointed at the femur, in freshly-killed specimens, and removed through a slit in the skin near the articulation, leaving the foot intact. These mouse "hams" were eagerly accepted by all the young *obsoleta,* and also by young *Coluber c. flaviventris* and *Pituophis sayi sayi* subsequently tested. The remainder of the still-warm carcasses was readily accepted by adult snakes.

In July of 1948 I collected a female garter snake *(Thamnophis ordinatus parietalis),* 35 inches long, which had been feeding upon the young of songbirds in preference to goldfish which were available in the same backyard area.

An informal fish pool, surrounded by limestone rock and low evergreens and shrubs, with a few taller trees, provided a nesting site for cardinals, brown thrashers, and wood thrushes. The pool contained hyacinths and goldfish 3 to 4 inches long. Numerous bird nests were noted in the shrubbery, several within 3 feet of the ground.

The owner of the garden said that he often observed the snake basking motionless in the shrubs, and that birds were always excited by it. No fish had been taken as he kept count of these. Frogs had not been heard or seen in the area. Sloughs not much smaller than the garter snake captured had been found periodically as early as 4 years before.

An intensive search revealed no other reptiles or amphibians, and but few garden slugs in the yard, which is in a residential district not near any unimproved land.

On the third and fifth days after its capture, feces containing typical wing-feather shafts of nestlings were passed. However accustomed to an avian diet the snake may have become in nature, its adjustment to a piscine diet in captivity was immediate; smelt as long as 6 inches were readily taken as food.—DANIEL M. WATSON, 3733 Garfield St., Kansas City, Mo.

A New Species of Toad, with a Discussion of Morphology of the *Bufonid* Skull

By OTTYS SANDERS

There occurs in the vicinity of Houston, Harris County, Texas, and adjoining counties, a species of toad which differs from other toads of Texas. In certain features, it resembles *Bufo terrestris* (Bonnaterre) and, in others, it is more like *Bufo americanus americanus* Holbrook. It has accordingly been thought of as being one or the other of these species, the former by Harwood (1932:57); the latter by Wright and Wright (1938:20). More recently, though not supported by publication, it has been regarded as *Bufo terrestris americanus* Holbrook by various herpetologists who consider *Bufo americanus* and *Bufo terrestris* as subspecies of each other. It is the purpose of this paper to describe the Houston, Texas, form as a distinct new species.

The status of *Bufo americanus* in Texas has long been confused. Brown (1950:49) confines it to the northeastern counties bordering Oklahoma and Arkansas; Wright and Wright (1949:140) no longer extend its range into Texas. Bragg and Sanders (1951) summarize the matter and doubt the existence of *B. americanus* in northeastern Texas, southern Oklahoma, adjacent Arkansas and Louisiana, and describe a new subspecies, *Bufo woodhousei velatus* as characteristic of this area.

From a study by the author of *Bufo americanus* and associated toads, involving examination of over two thousand toads from twenty-three states, certain general conclusions may be presented, prior to more complete publication, as follows. Those toads commonly considered to be *Bufo americanus americanus* (*B. t. americanus*) appear to be limited in distribution by climatic factors, especially temperature. Without defining their exact distribution in this paper, it can be stated that their southern extent roughly corresponds to the limits of the upper Austral Life Zones of Merriam (1898:Bull. No. 10) which extend no closer to Texas than northern Arkansas. On the fringe of this cooler zone, inhabited by *B. a. americanus* and extending into warmer climates, populations of toads resembling *B. americanus* occur at various points. These have been referred to as dwarf *B. a. americanus* (Bragg:1939) or a distinct subspecies of *B. terrestris* (Smith:1950). Such a population occurs in southeastern Kansas (Smith. 1950:82) coincident with the invasion of a warm area into Kansas; in Oklahoma (Bragg. 1940:75); and in southern Illinois (P. W. Smith, in litt.) where a warm area extends up the Mississippi Valley to that region. Only one such population, from southwestern Missouri, has been available for study of cranial characters, but preserved specimens from the areas mentioned above have been examined. These various populations are far from uniform, agreeing principally in body size, in the lack of the characteristic large warts of *B. americanus,* and in having a diminution of venter spotting. Otherwise they retain largely the external characteristics of *B. americanus.* A study, however, of the crania in the series from southwestern Missouri showed considerable similarity to the new species described herewith both in shape of the prootic and in the cancellous nature of the cranial ridges. The writer believes that these various populations are not *B. a. americanus* and suggests the possibility that they may be intergrading or hybrid toads,

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though their true identity must be confirmed by further study and comparison of their crania.

Geographically and climatically, therefore, the Houston, Texas, species is isolated from any direct connection with *Bufo a. americanus*. As regards the so-called dwarf races of *B. americanus*, none occur, so far as is known, in the bordering state of Louisiana on the east, whose coast is continuous with that of Texas. It is believed (Bragg and Sanders. 1951: 376) that the Oklahoma dwarf race does not cross the Red River bordering Texas on the northeast and that such records are referable to *B. w. velatus*. The only avenue which has not been fully explored is that which runs along the eastern border between Texas and Louisiana northward to southwestern Arkansas. While, so far, *Bufo houstonensis* (the new species), has not been secured from this region, it is thought likely that it may be found there and on the basis of possibility extend into northeastern Oklahoma, where it would occur in the same area with a so-called dwarf race of *Bufo americanus*.

Climatically, the Houston area corresponds more closely to the region inhabited by *Bufo terrestris*. It has been pointed out by Netting and Goin (1946:107) that *Bufo americanus* and *Bufo terrestris* occupy mutually exclusive ranges and meet in the southern portion of their range along the Fall Line, that intergrades occur, and for these reasons the two should be considered as subspecies. They further believe that *Bufo t. terrestris* is a lowland representative and *Bufo t. americanus* an upland form in the southern portion of its range. However, the total range of *Bufo americanus* certainly would appear from the literature to be both upland and lowland, from sea level at Mount Desert Island, Maine (Manville. 1939: 174), to the heart of the Green Mountains of Vermont (Fowler and Cole. 1938:93). Of more significance in the separation of these two species along the Fall Line would appear to be climatic factors, for it is here, according to the climatic zone separation of Merriman, that the cool zone inhabited by *Bufo americanus* meets the warmer zone populated by *Bufo terrestris*.

As regards intergrades, Neil (1949:30-32) finds hybrids between *Bufo terrestris* and *Bufo fowleri* in Georgia but no intermediates between *Bufo americanus* and *Bufo terrestris*. An examination of the extensive collections of Louisiana and Mississippi toads assembled by Dr. Cagle at Tulane University and Dr. Lowery at Louisiana State University does not indicate, so far as can be determined, the introduction in these states of forms intermediate between *Bufo americanus* and *Bufo terrestris*. *Bufo fowleri* and *Bufo terrestris* extend into southeastern parishes of Louisiana as noted by Viosca (1926:308. 1949:10) and Anderson, Liner and Etheridge (1952:275-276). I am in agreement with Anderson et al., that certain toads from Washington Parish, La., look like hybrids between *Bufo terrestris* and *Bufo fowleri*. It seems, therefore, more likely that if intermediates between *B. terrestris* and *B. americanus* occur, they would be found northward in North Carolina or Virginia rather than southward where *B. fowleri*-like toads predominate.

The possibility of *B. terrestris* extending along the coastal plain west of the Mississippi Valley is not believed likely by Viosca (1926:309) because of ecological conditions preventing its approach to the eastern border of the Mississippi River. Cope (1889:290) and others have been equally convinced of the southward limitation of its range. Reports of *B. terrestris* in Arkansas are to be questioned since it has been shown

that, in at least one instance (Bragg and Sanders. 1951:375), such a specimen was an intergrade between *Bufo w. velatus* and *B. w. fowleri.* Furthermore, failure so far to find any populations of *Bufo houstonensis* in Louisiana would indicate its complete separation geographically from the nearest approach to *B. terrestris.*

In defining *Bufo houstonensis,* the species is supported by anatomical considerations as well as external characteristics. To do this, it has been necessary to make a comparative study of Bufonid crania and combine modern descriptive methods with osteological interpretation. The two will be presented in sequence so far as it is possible to do so.

Bufo houstonensis sp. nov.

It is largely through the assistance of Mr. John C. Wottring of Houston, Texas, that sufficient material for study of this toad species has been secured. He also revived interest by demonstrating in voice recordings its uniqueness among associated toads. It is proposed, therefore, in recognition of these services that the species be known by the common name of *The Wottring Toad.*

Diagnosis.

A small species with no great variation in size between adult males and females. While bearing a superficial resemblance to *Bufo americanus* and *Bufo terrestris,* it is distinguished from both by its large postorbital crest which is usually heavier than its interorbital crest; and by the uniqueness of its dorsal pattern, tending to make the toad appear obliquely striped. It is further noted for its heavy supratympanic ridge which bends inward. Warts are not as large as in *Bufo americanus* and the number in a spot is variable, from one to five, but usually not more than three. Large light-colored tubercles, often tipped with orange or brown, occur on the tibia. The venter spotting is largely confined to the anterior one-third to one-half of the abdomen and generally clustered midventrally rather than extending toward the sides. Structurally, the species has a rectangular type of otic capsule, well ossified. It lacks the parietal "club" of *Bufo terrestris.* The eggs are separated by compartments.

Range.

The range so far determined is limited to Texas and includes Harris County, westward to Colorado County (6 mi. E. Columbus: S3031-38, S3044), thence northwest to Burleson County (Caldwell: Tex. Coop. Wildlife Mus. of A. & M. College. Nos. 7068, 7069), thence eastward to Liberty County (6 mi. S. Liberty; Coll. Werner Gottsch). On the basis of possibility the range of the species is projected along the eastern border of Texas to eastern Arkansas and northeastern Okla.

Holotype.

In Sanders collection, No. S3006, an adult female from Fairbanks, Harris Co., Texas; secured from a breeding chorus, May 18, 1952, by Mr. John C. Wottring and Walter J. Greer. Holotype is being deposited in the Univ. of Illinois Museum of Natural History. *Paratypes,* twenty-two preserved specimens: Nos. S3004-5, S3007-26; and ten skeletons, Nos. S2093-3002; all from the same locality as the holotype, on the same date, and by the same collectors. Other specimens examined, forty, including nine from Austin County, Tex., and two from Burleson County, Tex.

Description of Type. (Fig. 1)
(Measurements)

A mature female, snout-vent length 65.5 mm.; head width (ventrally, from rictus of jaws on either side) 23 mm.; head length (ventrally, from

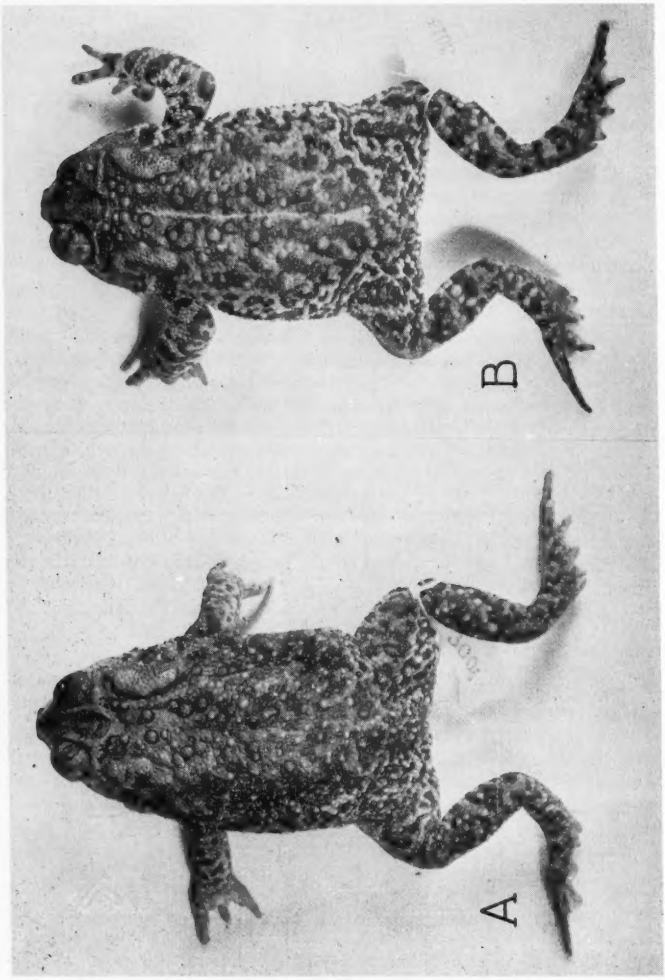

Fig. 1. (A) Type specimen *Bufo houstonensis* No. 3006, female; (B) Paratype No. 3013, male.

rictus of jaws to median lip notch) 17:5 mm.; tympanum, 5 mm. x 4.5 mm. (longer measurement vertical); parotoids (lxw, left to right) 12

mm. x 6 mm., 11 mm. x 6 mm.; interparotoid distance at closest approach 11 mm.; tibio-fibular portion of leg (knee to heel) 22 mm.; heel to tip of fourth toe 33.5 mm. The canthus rostralis forms a broad ridge, approximately 2.5 mm. wide. The nares are far apart, 4 mm., equidistant between the corner of eye and median lip notch. The snout viewed dorsally is blunt. The postorbital ridge to its junction with the supratympanic ridge is 6 mm., and its breadth 2 mm. The supratympanic ridge is 2.5 mm. long, 2 mm. broad. The interorbital ridges diverge posteriorly but their breadth increases, so that the distance between ridges at their anterior origin is approximately equal to the distance between them posteriorly at their juncture with the postorbital ridges.

In addition to the holotype, a series of fifty-nine males were measured with a snout-vent length of 49 mm.-62 mm., the majority being between 53 mm.-59 mm.; seven mature females measured 57 mm.-65 mm., the majority being 63 mm.-65 mm.

(Color, pattern)

The dorsum of the preserved (formalin) specimen has a basic ground color of light gray-brown, superimposed on which in a herringbone arrangement from the mid-dorsal stripe are darker brownish blotches, somewhat lobed or falcate and without accentuated margins. Light areas between these blotches give the specimen an obliquely-striped appearance. In life, the basic color of the dorsum was purplish-gray; the dark pigment splotches were greenish.

In common with other toads, there are spots enclosing warts. The spots are black, small in size, forming little more than margins around the bases of the enclosed warts, and in life they were rimmed with yellow. The more prominent of these spots are those situated in the inter-parotoid area which are considered in relation to their position in respect to the parotoid. The anteparotoid pair enclose two and four warts respectively; the midparotoid pair, a single wart each; the postparotoid pair, three warts each. Warts in these spots, olive-colored in life, are somewhat rounded dorsally and, while larger than other tubercles on the dorsum, do not approach the large wart size of *Bufo americanus*. In addition, the skin has many smooth-surfaced, rounded and somewhat flattened warts of various sizes, those in lighter areas being a light orange color in life. Fine tubercles also exist but are not of a size to indicate spininess. Laterally on the dorsum, warts are more conical and densely packed. The general pattern of the dorsum continues on the sides with darker pigment bands fusing to make a network and obscuring the lateral stripe. A lateral row of tubercles, frequently bordering the lateral stripe in Bufonidae, is not prominent.

The dorsal surface of the femur is dark-striped and, in life, the interspaces between stripes was straw-colored. The dark bands on the tibia are broader, tending to form a network. The larger tubercles on the tibia, whitish in the preserved specimen, were light orange, brown-tipped, in the live toad. Small dark tubercles are in dark cross bands but the larger whitish tubercles are not so restricted to lighter areas.

The parotoids are approximately twice as long as broad. They are lighter in color than the dorsum and are pitted. Their position in respect to the supratympanic ridge is somewhat medial and they diverge posteriorly.

(Cranial crests) (Fig. 2)

While a more apt discussion of cranial crests is taken up in the skeletal description, these features may be noted. The interorbital ridges are far apart anteriorly (3.5 mm.) and diverge posteriorly. They increase sharply in size near the posterior border of the eyelid bar. A parietal

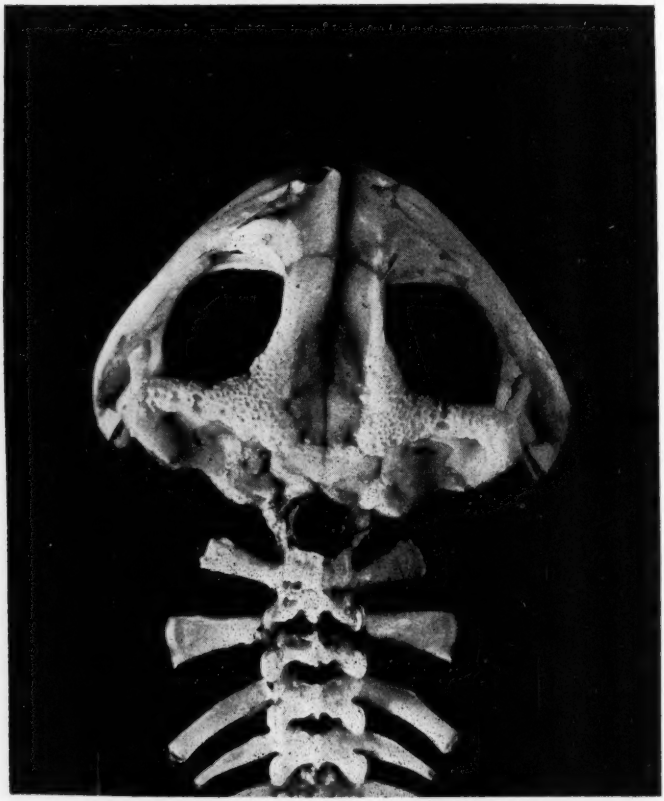

Fig. 2. Skull of *Bufo houstonensis,* paratype No. 3000.

spur on either side decreases abruptly in height, bends downward and inward so that the two almost meet in the midline.

The postorbital ridges are notable for their size, being heavier than the interorbital ones and maintaining this robust structure throughout their length. The interorbital and postorbital ridges are of approximately the same length to the point of their junction. The supratympanic ridge which is also heavily constructed has been mentioned previously. The tympanic ridge is a short, sharp extension from the postorbital ridge. The preorbital ridge is short and sharp.

(Eye, tympanum)

The eye has a light spot at both its anterior and posterior corners, and an area below the eye is depressed. The valley between the canthus rostralis of either side is broad and scooped out, since the ridges on the canthus rostralis do not meet anteriorly at their apex. The tympanum is placed vertically and its dorsal border is not in contact with the supratympanic ridge.

(Venter)

The throat is unmarked. The pectoral area in addition to the large pectoral spot has a few smaller ones; the anterior one-third of the abdomen has small grayish spots confined primarily to the central midventral portion and not spreading toward the sides. The abdomen is granular but not spiny. Undersurfaces of the arms and legs are not spiny though some small tubercles do occur in the central anterior surface of the foot.

(Feet, hands)

Toes are 1, 2, 5, 3, 4, in increasing length. The larger metatarsal tubercle is longer than broad (4.5 mm. x 3 mm.), the smaller metatarsal tubercle is conical. The fourth toe is broadly webbed and its first and second subarticular tubercles divided. On the hand there is a well-developed thenar tubercle. The metacarpal tubercle is somewhat rounded and the subarticular tubercles of the fingers are heavy. There are two rows of tubercles on the latero-posterior surface of the arm, those of the upper row being larger than those of the lower.

GENERAL FEATURES OF BUFO HOUSTONENSIS

Derm Characters.

The texture of the skin in *Bufo houstonensis* is dry to the touch rather than moist as in *Bufo americanus*. The skin pattern, somewhat variable, appears to be altered primarily by densities of pigmentation in specimens. The background color is frequently yellowish buff or straw and, superimposed on this, are darker streaks of gray-green with black spots. Considerable metachrosis exists, however, so that specimens may vary from light green on gray-purple to a mixture of lighter and darker browns. Noteworthy are large light-colored tubercles, frequently orange or white, tipped with orange, toward the sides and on the tibia.

The mid-dorsal stripe is usually narrow; the lateral stripe is variable both in width and color, from grayish-yellow to greenish-white. The sides usually have a compact network of dark green or brown bands on white or gray.

The tibial bands are not uniform either in size or arrangement and a study of the second tibial band demonstrated a variety of wart combinations, depending not only upon the breadth of the band but the wartiness of the tibia, more pronounced in some specimens than in others. The most common arrangement appeared to be a combination of from one to three larger light-colored tubercles with several smaller dark green ones. In only two specimens of the paratype series was the size of tubercles sufficiently large to be noteworthy, although, in general, the larger warts of the tibia are larger than corresponding ones on *Bufo fowleri* and smaller than in *Bufo americanus*. The significant feature of tibial warts in *Bufo houstonensis* would appear to be their color, rather than their arrangement and size.

The throat of breeding males is two-toned, being darker above the vocal sac. It varies from rusty brown or yellow anteriorly to blue-green

or greenish-black posteriorly. The nature of venter spotting has been discussed earlier.

The first subarticular tubercle of the fourth toe is almost always divided, the second frequently so. In an examination of 43 males, 21 had the first divided, the second single; 7 had both divided; 11 had both divided on one foot and the second single on the other; 4 had both tubercles single on both feet. Of the 9 females examined, 5 had both tubercles divided and 4 had the second tubercle single.

(Warts)

Since a great deal of taxonomic significance has been attached to the size and number of warts in a spot in such forms as *Bufo americanus, Bufo fowleri* and *Bufo woodhousei,* a similar study was made of this arrangement in *Bufo houstonensis.* Spots in the interparotoid area appear to have more permanence and more uniformity than those on the remainder of the dorsum. Of the three pairs previously mentioned, the postparotoid pair appears to be the more diagnostic. In *Bufo americanus,* the largest warts of the dorsum usually occur here and the number is more consistent. A study of the wart arrangement in the postparotoid pair of spots in the paratype series of *B. houstonensis* demonstrated no consistent arrangement either in number or size of warts. Fifty per cent of the series had not more than two warts per spot; the remaining 50% had from three to five warts in at least one spot of the pair. Only 23% had more than three warts in one spot of the pair. The number of warts in corresponding spots of the pair is also variable. Fifty per cent had an equal number: 1, 1; 2, 2; 3, 3; 5, 5; the remainder had unequal numbers in corresponding spots of a pair. Size of warts in a single spot is also variable, and may include a mixture of sizes, the warts being separate or in various degrees of fusion. It is suggested that fusion of warts would reduce number and increase size. It also appears reasonable that warts crowded together in small spots would have more opportunity for fusion.

(Eggs.) (Fig. 3.)

Eggs were obtained by injecting anterior pituitary extract abdominally in copulating pairs. Fertile eggs were deposited, hatched in forty-eight hours and subsequently developed into tadpoles. Color notes were not made of the freshly laid eggs but in formalin they are dark brown above, lighter brown below. They were laid in a single row in a jelly tube with both inner and outer envelopes, the inner one distinct, the outer one somewhat scalloped at intervals (Fig. 3). The structure of the egg strings was studied after staining with .1 of 1% silver nitrate and disclosed that the eggs were separated from each other by compartments. While in some portions of the egg string, compartments were not demonstrated, in others they occurred with regularity, and it is thought that mechanical handling of the egg strings and other factors might be responsible for this seeming lack of uniformity.

After calibrating with a stage micrometer, measurements were made from fresh (not formalin) material through the kindness of Dr. J. P. Harris of Southern Methodist University with the following results. Outer envelope 3.2 mm-3.5 mm.; sheath .3 mm.; vitellus 1.4 mm-1.7 mm.

The tadpoles have not yet been studied except to observe that there was no mottling of color as found in *B. w. velatus* (Bragg and Sanders: 1951).

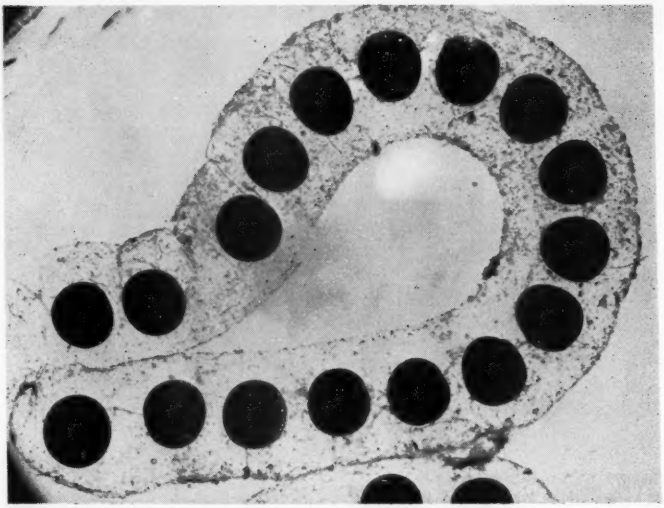

Fig. 3. Egg string of *Bufo houstonensis* showing scalloping.

(Spermatozoa)

Spermatozoa were extracted from the testes of males taken from a breeding chorus and the sperm stained according to the method described by Kantor (1948) for human smears. The spermatozoa heads of *Bufo houstonensis* measure .017 mm.-.023mm., are staff-shaped with the acrosome long and sharp. The head broadens slightly posteriorly and a light-staining area occurs before its junction with the tail. The tail is ribbon-like, longer than the head but not twice as long. It broadens medially and ends as a filiform strand. While similar in appearance to that of *Bufo vulgaris* as figured by Boulenger (1897:76), it is believed that the undulate margin of the tail is due to arrested motion rather than to a crest on the tail itself. The head stains intensely, while the tail remains clear except for its walls. Immature sperm with well-developed tails have considerably broader heads which resemble a trypanosome somewhat in shape and possess a crest along one side of the head. Whether this crest is retained by the mature spermatozoan has not yet been determined.

Difficulties of deciding the maturity of sperm in preparations from the testes where various stages are represented suggest the desirability of securing the spermatozoa from the seminal ducts or elsewhere. However, because of different staining properties, especially as regards the heads, it is believed that the immature forms have been differentiated from the mature ones in this study.

(Voice)

The voice of *Bufo houstonensis* resembles that of *Bufo terrestris* rather than that of *Bufo americanus* if a comparison is made to voice recordings in *Voices of the Night* (Cornell Series: Comstock Pub. Co.).

Since considerable emphasis has been placed on voice as indicating relationships in Salientia, certain features are pointed out without confirming or denying this belief, prior to a more complete study of the mechanism of its production.

The usage of the terms "internal" and "external" vocal sacs is a misnomer, for the vocal sacs themselves in both instances are simple diverticulae of the lining of the mouth cavity. Liu (1935:20) summarizes the matter: "Although the true internal vocal sac is present in either case, the structure is customarily called external when the external *skin* is visibly modified, and internal when it is not."

If one compares macroscopically the vocal sac of *Bufo americanus* (internal) with that of *Bufo fowleri* (external), the primary differences appear to be those of size, thickness of walls, pigmentation and possibly membraneous attachment to the skin of the throat. In *Bufo americanus*, the vocal sac appears to be of thinner construction, occupies less area when collapsed, and is darkly pigmented. In *Bufo fowleri*, the vocal sac is of thicker construction, occupies more area when collapsed, and its larger portion is unpigmented. It is significant that in forms of *Bufo americanus*, which, by those external characteristics generally used in separating it from *Bufo fowleri*, appear to indicate hybridization, an alteration in the vocal sac is exhibited, the posterior portion being of thicker construction and with loss of pigmentation in varying degrees. This seems to indicate clearly the possibility of the partial conversion of the "internal" type of vocal sac into the "external" type. If there is a relationship between vocal sacs and the type of voice produced and if these factors are inherited to varying degrees in hybridization, as seems indicated in structure by the above, and in voice as noted by A. P. Blair (1941), the factor is certainly unstable.

Since amphibians represent a primitive development of the larynx in vertebrates according to Negus (1949:XIX), who also believes they do not possess vocal cords but have instead a non-return valve which may function to produce sound (ibid. p. 47), there may be limitations to the variety of calls capable of being produced so as to register distinctly in the human ear. It is well known that there are variations in perception among individuals and that the human ear is not an infallible record of sound at certain pitches. A more satisfactory comparison between the calls of various species of frogs and toads would be their graphic record made by an oscillometer.

Mr. Jerry Stillwell, who has published excellent recordings of bird voices, has kindly analyzed the "pulses" (number of repetitions per second) of the voice of *Bufo americanus, B. terrestris* and *B. fowleri* as recorded in *Voices of the Night* (ibid. ref.). In these three species no definite relationship is shown between pitch and pulses, and the pitch seems to be constant throughout the call.

THE SKELETON

While it is not customary to designate skeletal elements in describing new species or subspecies of Amphibia, this is to be lamented rather than approved. In a group noted for paucity and extreme variability of taxonomic characters, any supplementary skeletal features are highly desirable for purposes of practical recognition as well as for theoretic considerations. Since it is possible to prepare skeletons from preserved frogs and toads with ease by use of solutions of sodium hypochlorite, lack of skeletal

material is no longer an obstacle for such study (Sanders; paper in this issue of Herpetologica).

Probably the greatest deterrent factor in skeletal examination of toads has been lack of information on the structure of the Bufonid skull. There appears to be almost a total lack of knowledge of the crania in North American bufonids. W. K. Parker (1881) compares the morphology of the bufonid head in *Bufo melanostictus, B. pantherinus, B. chilensis, B. vulgaris* and other foreign species. Ramaswami (1936), referring to the work of Parker as the most recent, describes the internal organization of the olfactory region in several of the toads studied by Parker. While these papers are excellent from a comparative viewpoint, they do not describe in sufficient detail certain structural features with which this paper is concerned. It becomes necessary, therefore, before treating *Bufo houstonensis* specifically, to discuss and define certain terms heretofore missing or vaguely defined that are essential to cogent comparison of bufonid crania.

Clarification of comparative structures in bufonid skulls is beset with difficulties because a primary understanding of the homology of parts has not been established. Cope, Gaup and others deny the presence of a squamosal or a quadratojugal and define these as a paraquadrate and quadratomaxillary. Eaton (1939:96-97) disagrees with Parker (1871) that a frontoparietal is formed by fusion of frontal and parietal bones. He finds that in tadpoles of *Rana clamitans, Hyla regilla, Bufo californicus* and *Scaphiopus hammondii* "the frontoparietals begin as single sliver-like units." In larvae of the same species at early metamorphosis "the synotic tectum extends farther forward and the frontoparietals have grown backward over the cartilage . . . and also reach forward to the anterior end of the cerebral hemispheres." In a true sense, therefore, a frontoparietal may not exist in Salientia, nor has its homology been verified. Cope (1889) considers the nasals absent or vestigial and terms the lateral triangular bones in the nasal area as prefrontals. In modern Amphibia, as contrasted to primitive ones, it is commonly believed that exoccipitals rather than occipitals exist as bones. The writer believes that the term, prootic, should be restricted to an orbital bone in front of the otic capsule rather than used to include the tectum of the otic capsule as is customary.

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With such a diversity of opinion, therefore, based on the lack of a more comprehensive knowledge of the fundamental homology of cranial parts in Salientia, it is inescapable that descriptive terms coined in relation to cranial structures will perpetuate the errors of the past. If, however, a comparative description is to be made between the crania of different species of Bufonidae, it seems advisable to use the tools and terms we have, while at the same time questioning their correctness. For the most part, therefore, terms in common usage are retained and new terms are proposed with the knowledge that they may not reflect true homology.

There have been examined one hundred and fourteen skeletons, still intact, and a considerable number, of which no record has been kept, completely disintegrated in studying certain features. The 114 skeletons are distributed as follows: 25 *Bufo americanus,* 15 *B. fowleri,* 12 *B. houstonensis,* 10 *B. terrestris,* 6 *B. w. woodhousei,* 6 *B. w. velatus,* 9 *B. valliceps,* 3 *B. compactilis,* 4 *B. cognatus,* 1 *B. boreas,* 1 *B. d. debilis,* 1 *B. d. kelloggi,* 1 *B. alvarius,* 6 *B. horribilis,* 3 *B. nayaritensis,* 1 *B. gemmifer,* 5 *B. marmoreus,* 2 *B. coccifer,* 1 *B. simus,* 2 *B. philippinicus.*

Interorbital Ridge.

Interorbital and postorbital ridges are generally referred to as single features, while a study of their structure discloses that each ridge is a combination of two or more portions. The interorbital ridges between the eyes on the lateral borders of the frontoparietals are divisible grossly into two sections, an anterior *frontal ridge* and a posterior *parietal ridge* (Fig. 4). Their limits may correspond to the primary extent of the frontoparietal in the tadpole and its subsequent growth in the adult,

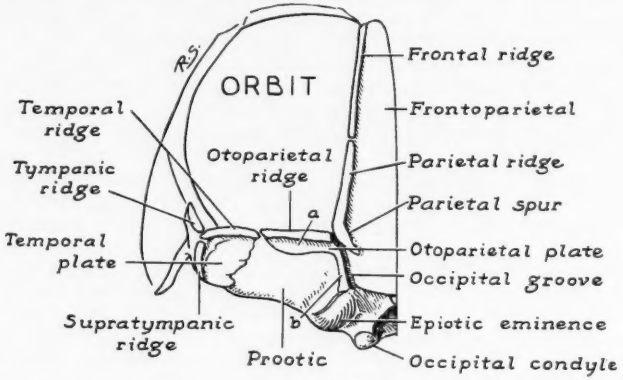

Fig. 4. Schematic diagram of Bufonid skull. *a.* transverse portion of otoparietal plate; *b.* longitudinal portion.

though this has not been determined. The size and nature of ridges on these portions are often in contrast and their composition has not been studied before, so far as is known.

It would appear, in well-defined interorbital ridges, that the upturned lateral border of the frontoparietal constitutes only an inside part of the ridge and that the remainder is formed by a fusion with or separation from the so-called "perpendicular lamina of the frontoparietal" (Fig. 5). Where frontoparietal and perpendicular lamina are widely separated from each other, as is frequently the case in the parietal area, the space between is filled with bony matter, forming a broad parietal ridge. That the perpendicular lamina of the orbit may be a separate bony element fused with or separated from the frontoparietal is indicated in forms of *Bufo fowleri* from Massachusetts, where the seam formed by union of the edges of the frontoparietal and perpendicular lamina may be opened and the two separated, disclosing a large central space between them. In *Bufo americanus,* a similar space exists in the parietal area, though much restricted.

A further feature relates to the beginning of the frontal ridge at the anterior end of the frontoparietal and a theory is advanced which remains to be substantiated by sectioning and careful study of the ridge histologically. In specimens of *Bufo americanus* which appear to have frontal ridges converging anteriorly, a study of the skull discloses two possibilities: (1) that the ridge originates near the medial anterior margin of the frontoparietal as a pinched-up ridge, in contrast with its origin in other toads at the lateroanterior border of the frontoparietal by an upturning

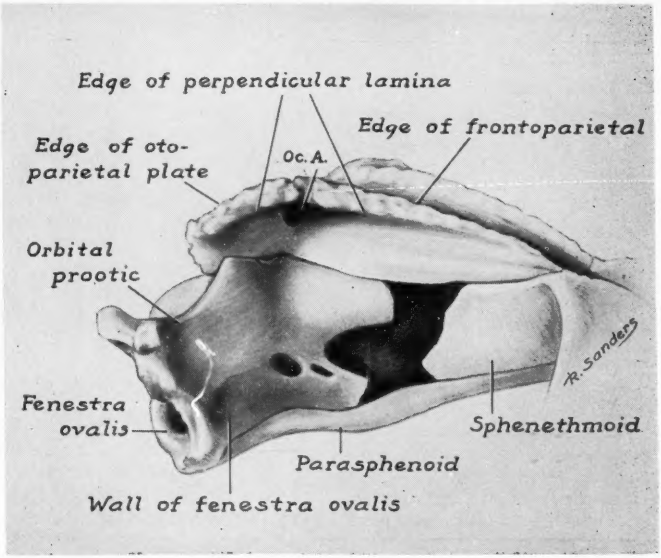

Fig. 5. Lateral view skull of *Bufo houstonensis* showing perpendicular laminae and nature of cranial ridge formation. *Oc. A.*, aperture for occipital artery.

of its edges; or (2) that the perpendicular lamina becomes a flattened plate at its anterior end, lies on the dorsal surface of the sphenethmoid (ethmoid) and, while appearing to be a part of the frontoparietal, in reality is beneath it: that the frontal ridge begins as in other species of toads by the upturning of the lateral border of the frontoparietal and, since it is superimposed on the flattened laminal plate, gives the incorrect visual impression explained in the previous theory. The second explanation is believed to be the correct one.

If this second explanation is correct and if the perpendicular laminae constitute separate bony elements fused with the frontoparietals, a relationship to extinct forms is suggested in that the flattened anterior portion of the lamina may correspond to a prefrontal, its posterior portion along the side of the orbit, a postfrontal; and its postorbital process, a postorbital.

The size of interorbital and postorbital ridges is often augmented by a folding of walls and by calcifications. Thus is produced a cancellous or encrusted appearance which in different species of bufonids may be of varying texture.

Postorbital Ridge.

The skeletal area back of the eyes may conveniently be called the *postorbital shelf* in toads. It comprises the dorsal surface of the otic capsule, a postorbital process adjoining the parietal portion of the frontoparietal, and laterally, a process attached to the squamosal. The anterior border of the postorbital shelf frequently has a crest known as the post-

orbital ridge. This ridge is made up of at least two separate components and, in order to define the two portions, it is desirable to discuss the separate structures on which they occur.

Otoparietal Plate

For the "postorbital process of the frontoparietal" (Parker: 1881), also known as the "tectum supraorbitale" (Bolkay, 1933:pl.19), the name *otoparietal plate* (Fig. 4) is suggested because of its situation between the otic capsule and the hinder portions of the frontoparietal. Furthermore, this name is suggested because in certain Mexican species, such as *Bufo marmoreus* and *B. nayaratensis,* the frontoparietal appears to have a short postorbital process in addition to the otoparietal plate. The otoparietal plate varies in position in different species, but in *B. americanus, B. fowleri* and other toads it is composed of a transverse portion at the orbit (Fig. 4, a) and a longitudinal portion (Fig. 4, b) along the medial side of the otic capsule. The plate at the orbit, either singly or in conjunction with an orbital lamina, frequently forms a crest on its dorsal edge which may be known as the *otoparietal ridge* (Fig. 4), and constitutes the medial section of the postorbital ridge.

Before discussing the lateral portion of the postorbital ridge and the structure on which it occurs, further terms associated with the otoparietal plate are defined. The word *occiput* has been employed to refer to the rear part of the head and *occipital,* as pertaining to the occiput (Smith: 1950, p. 315). While the word, occipital, can be ambiguous when referring to the hinder portions of the frontoparietal, and the lack of an *occipital bone* is believed correct, its usage herewith conforms to custom and refers to nothing more than the rear part of the head beyond the orbit. Between the otic capsule and the occiput is a groove or fossa, herewith named the *occipital groove* (Fig. 4). It supports an occipital artery (Richard Baldauf, in litt.). The longitudinal portion of the *otoparietal plate* may lie along the groove, extending only on its lateral banks as in *B. houstonensis,* or may extend further on to the prootic as in *B. horribilis.* In some toad species, such as *B. valliceps,* the position of the otoparietal plate is different. While having a somewhat vertical portion at the orbit, its medial edge is turned up and fuses with the upturned edge of the occiput to form an *occipital ridge* (a term already in usage) which may or may not parallel the occipital groove, and the latter is often sunken lower in the skull as a result of the formation of this ridge.

Temporal Plate

The lateral portion of the postorbital shelf is formed by a bony plate fused to the squamosal. This *temporal plate* (Parker: 1881) (fig. 4) overlaps or unites with the prootic in many species of Bufo. A ridge, when present, on the anterior margin of the temporal plate and herewith called the *temporal ridge* (Fig. 4) extends medially to a junction with the *otoparietal ridge* and the combined two make up the so-called postorbital ridge.

The upturned *lateral* edge of the temporal plate, either separately or in conjunction with the posterior process of the squamosal hammerhead and the attachment between the two, forms the *supratympanic ridge,* frequently known also as the preparatoid ridge. The *tympanic ridge* is that on the zygomatic process of the squamosal. The attachment of the temporal plate to the squamosal head varies in different species of Bufo and will be discussed later in this paper.

Epiotic Eminence.

At the medio-posterior border of the postorbital shelf is an elevation referred to by Parker (1881) as the *epiotic eminence* (fig. 4) and which is in part above the posterior semicircular canal of the membranous labyrinth. It may be thought of as made up of an ossified hinge from the exoccipital; a central portion, cartilaginous in some species; and an anterior facet formed by the prootic. This theoretic consideration is subject to considerable variation in actual appearance, for, when the prootic portion is not well ossified, it would appear to blend in with the central portion so that no delimitation between the two may be observed. In various species of toads, the epiotic eminenec appears to differ in its angular position in relation to the sagittal axis of the skull, in its elevation in regard to the postorbital shelf, and in the ossification of its parts.

Orbital area.

Attention has previously been directed to the so-called "perpendicular laminae of the frontoparietal," which form part of the medial orbital walls and extend postorbitally to the otoparietal plate. Anteriorly, the sphenethmoid extends as a plate in front of the eye but posteriorly, the

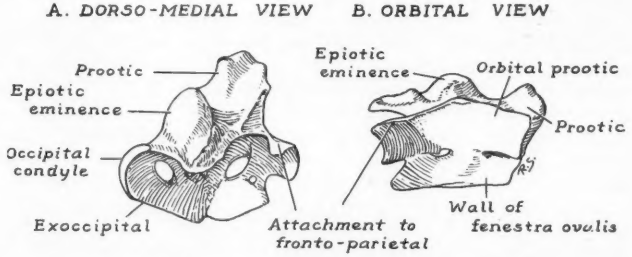

Fig. 6. Bones of occipital region, showing attachment of frontoparietal to orbital prootic and view at rear of eye.

lower orbital walls contain bony elements little understood. It is commonly thought that the prootic bounds this area and extends on to the tectum of the otic capsule. If, however, we consider the dorsal roof of the otic capsule to be the prootic (as is customary) there would appear to be definite separation between the prootic of the otic roof and the band of bone in the orbit. In *Bufo horribilis* the roof of the otic capsule is largely cartilaginous but a bony wall separates the otic capsule from the orbital bone. The latter is therefore referred to as the *orbital prootic* (Figs. 5 and 6). It extends medially onto the main stem of the skull, gives off dorsally a process which makes attachment with the frontoparietal near the posteromedial corner of the orbit (Fig. 6). The frontoparietal therefore is anchored anteriorly by the sphenethmoid, near the corner of the eye by the orbital prootic, and posteriorly by the exoccipital. Below the orbital prootic is the wall of the fenestra ovalis. In many species of Bufo there also occurs in the orbit in front of the temporal plate an *orbital plate* arising from the stem of the squamosal.

Otic Capsule.

The shape of the otic capsule as represented by its roof, or prootic, is subject to considerable and important differences in species of Bufoni-

dae. This may be illustrated by comparing its triangular shape in *Bufo americanus* with its more rectangular or "bow-tie" like appearance in *Bufo terrestris*. Among species there are also significant differences in ossification, in vertical thickness of the capsule, placement of the fenestra ovalis, and freedom or encasement of the columella in cartilaginous tissue.

The purposes of this paper, however, are not to give a complete morphological picture of the bufonid skull, but to furnish a background for description and comparison of the skull of *Bufo houstonensis* with the crania of others, and to suggest that an analysis of species relationships with concurrent hybridization phenomena can and should be supported by more than dermal characters and external manifestations of bony structure.

Skull of *Bufo houstonensis* sp. nov.

It is understood that under the current holotype concept, a schism into the type would be introduced by designating a skeleton as the type skeleton. The skeletons cited herewith, therefore, are considered paratypes. They are ten, Nos. S2093-S3002, and additional locality data have already been presented. The following description is made primarily from skeleton No. S3000.

Dorsal aspect of skull (Fig. 2)

Premaxillaries are broader at their base than they are high; nasals broadly swollen, their crests far apart, and their medial borders in contact throughout their length; nasals are marked in front of the orbit by a preorbital ridge extending their length.

The anterior margins of the frontoparietals are somewhat rounded and closely approximate the posterior borders of the nasals. The sagittal suture between the frontoparietals is irregular, exposing a longitudinal

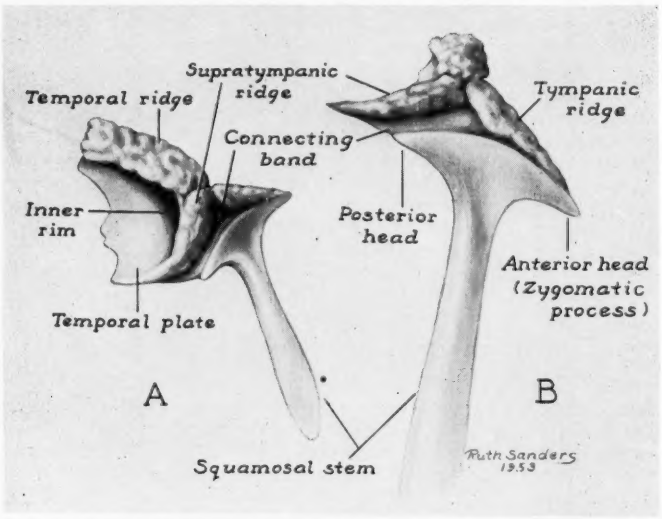

Fig. 7. The right temporal plate and its attachment to the squamosal in *Bufo houstonensis*. A. Dorsal view; B. Lateral view.

strip of the ethmoid wing and beyond this a portion of the endocranium. The frontal ridge is low and lightly cancellous, becoming more so near its junction with the parietal ridge; the latter is more heavily cancellous and ends in a strong parietal spur.

The otoparietal ridge is notable for its large size and heavy cancellous nature; the calcifications form a broad or triangular band on the surface of the otoparietal plate and between it and the parietal spur. The occipital groove is covered anteriorly and a bony cap extends into the orbit at the corner of the eye. The longitudinal portion of the otoparietal plate lies in the occipital groove and extends no farther on the prootic than the lateral banks of the groove and associated medial ridge of the prootic.

The temporal plate is U-shaped with an inner rim (Fig. 7) on its postorbital and lateral parts. Postorbitally, the space between the inner rim and the orbital plate of the squamosal is broad, filled with cancellous or spongy bone, and forms a broad temporal ridge which slopes gently toward the squamosal head, is but slightly smaller than the otoparietal ridge and of almost equal height.

The supratympanic ridge is elevated, broad and cancellous. In order to describe its formation, it is necessary to consider the attachment of the temporal plate to the squamosal head (Fig. 7). This is effected by a narrow bony band from the ventro-posterior edge of the temporal plate which proceeds to the posterior hammerhead of the squamosal, becoming broader as it does so. The squamosal head (posterior process) is ventral to the upturned lateral side of the temporal plate and the connecting band extends between the two. The space between the dorsal edge of the connecting band in its lateral aspect and the upturned lateral edge of the temporal plate (or inner rim) is roofed in with calcareous material and constitutes the supratympanic ridge (Fig. 7). The supratympanic ridge is broad anteriorly but diminishes in size posteriorly as the area between the connecting band and the temporal plate decreases. Furthermore, the temporal plate narrows and flattens posteriorly while the connecting band runs beneath it. The supratympanic ridge, therefore, terminates near the postero-lateral border of the temporal plate as a narrow smooth ridge formed by the temporal plate alone. Since the plate narrows posteriorly and the supratympanic ridge has lost its lateral reinforcements, this may account for its inward bending.

The shape of the prootic approaches that of a rectangle expanded subequally at its lateral and medial ends and with its posterior border concave. The dorsal surface of the prootic appears to be uniformly ossified. A ridge occurs on its medial border from the epiotic eminence forward and its anterior edge also appears elevated, though it is believed that the latter upturning may be due primarily to the orbital prootic extending above. For the most part, the dorsal surface of the prootic is flattened, not deeply depressed centrally as in *B. americanus*. Its latero-posterior end is turned upward and, viewed from the side, appears to be folded with dorsal and ventral walls not quite fusing but affording between them a cavity for attachment with the quadrate cartilage. The quadrate cartilage does not extend beyond the posterior borders of the temporal plate. Where the temporal plate overlaps the prootic, the latter is depressed.

The epiotic eminence is smaller than in *B. americanus* and rises above the postorbital shelf. It would appear to form a broadened plug at the

posterior end of the median ridge of the prootic. A process from the exoccipital forms the posterior hinge of the eminence above, encloses the double foramen for the 9th and 10th cranial nerves below, and constitutes a part of the fenestra ovalis. The posterior hinge of the epiotic eminence is at right angles to the sagittal axis of the skull, rises above the postorbital shelf and is generally convex on its outer surface. The central cartilaginous portion of the eminence is dorsal in position, oblique in relation to the sagittal axis of the skull, and of medium breadth. The anterior hinge of the eminence, being a part of the prootic, is confluent with the medial ridge of the prootic and would appear therefore to extend forward in a line with it.

Ventral aspect.

The triradiate vomers are small and widely separated from each other. The rod-like palatines are keeled on a portion of their free surface, expanded as they join the maxillaries, and terminate near but not in contact with the anterior end of the parasphenoid. The sphenethmoid is ossified.

The stem of the parasphenoid is longer than its cross piece at the extremities. The anterior end of the parasphenoid stem is furrowed, its posterior end notched. Its lateral wings underlying the fenestra ovalis are broadly expanded, terminating in an oblique margin.

The posterior wall of the fenestra ovalis is closely applied to a process from the exoccipital situated below the epiotic eminence and forming the large aperture for the 9th and 10th cranial nerves as previously mentioned. The postero-inferior occipital condyles are to be considered in relationship to the vertebral column.

Lateral aspect.

Maxillaries briefly overlap the premaxillaries; the ridge on the inner surface is rounded rather than sharp. They narrow before junction with the quadratojugal, but not sharply. The quadratojugal is sickle-shaped.

The anterior arm of the pterygoid is the longest and broadest; the other two branches are subequal, the ventral being the broader.

The stem of the squamosal is strong, is slanted obliquely forward so that the short, broad, zygomatic process of the squamosal head is slanted sharply downward. The equally broad posterior process of the head is accordingly slanted upward.

The fenestra ovalis is rounded and joins the epiotic eminence more directly than in *Bufo americanus*. The cartilaginous *operculum* covering the fenestra ovalis affords attachment for the opercular muscle and for the columella, whose proximal end joins the operculum by a convex footplate at the antero-dorsal margin. Probably because of the closer approximation of the columella to the epiotic eminence and its consequent greater distance from the tympanic membrane, the columella in *Bufo houstonensis* is longer and more durably constructed than in *Bufo americanus*.

DISCUSSION

Bufo houstonensis has been compared throughout the paper to *Bufo americanus* and *Bufo terrestris*, with the viewpoint that all three are distinct species though resembling each other in certain respects. It has been pointed out that climatic factors may be pertinent to an understanding of the contiguous ranges of *B. americanus* and *B. terrestris* along the Fall Line. The very great difference between *B. americanus* and *B. terrestris* in external characters is well known and needs no further elaboration.

Little, however, is known of the basic differences between the structure of their crania, since no descriptions, so far as is known, are extant. To describe their crania in detail is beyond the scope of this paper, but pertinent differences are summarized and these in turn compared with *B. houstonensis*.

(Differences between the crania of B. americanus and B. terrestris.)

1. In *B. americanus,* the otic capsule is foreshortened so that the prootic approaches the shape of a triangle; in *B. terrestris* the capsule is extended and the prootic approaches the shape of a rectangle.
2. In *B. americanus,* the dorsal surface of the otic capsule is densely ossified, extending to its lateral junction with the quadrate cartilage; in *B. terrestris,* the dorsal surface of the otic capsule is poorly ossified, laterally becoming flattened and cartilaginous before junction with the quadrate cartilage.
3. In *B. americanus,* the central portion of the prootic is deeply depressed, forming a cup for muscle attachment; its posterior border is slightly notched if at all. In *B. terrestris,* the central portion of the prootic is more flattened, muscle attachment is over a broader area; its posterior border is deeply notched.
4. In *B. americanus,* the central cartilaginous portion of the epiotic eminence is broad, the prootic portion ossified, the operculum a long oval and the fenestra ovalis constricted. In *B. terrestris,* the central cartilaginous area of the epiotic eminence is indistinct since the prootic is poorly ossified and forms a semi-cup-like swelling to fit into the ossified exoccipital process; the operculum is spherical and the fenestra ovalis large, rounded and not constricted.
5. In *B. americanus,* the posterior hammer-head of the squamosal is ventral to the upturned lateral edge of the temporal plate and the two separated by a bony band, often broad. In *B. terrestris,* the height of the posterior hammer-head of the squamosal is approximately on a level with that of the upturned lateral edge of the temporal plate and the two closely joined, not separated by a broad band.
6. In *B. americanus,* the inner rim of the temporal plate is not separated broadly from the dorsal edge of the connecting band except at the lateral apex of the plate and the rim extends only a short distance along the lateral wall of the plate. The supratympanic ridge formed is short, abruptly decreasing in size. Quadrate cartilage frequently completes the posterior end of the ridge. In *B. terrestris,* the lateral walls of the temporal plate are not as sharply turned up, the inner rim extends along the entire lateral wall of the plate. The supratympanic ridge formed is long and usually narrow. Quadrate cartilage lies beneath the plate and does not enter into formation of the supratympanic ridge.
7. In *B. americanus,* the otoparietal plate is placed transversely at the orbit with its longitudinal portion lying along the occipital groove; the occipital groove is open for its greater part, though its opening into the orbit may be roofed with calcareous material; the parietal spur is of medium size.

   In *B. terrestris*, the otoparietal plate at the orbit is folded back-

ward with its medial edge fused to the parietal spur. The perpendicular lamina forms in the orbit at the corner of the eye a small vertical plate, perforated by a fossa for the occipital artery, and with its dorsal edge folded inward in the orbit to produce a bony cap at the corner of the eye. The flattened and depressed surface formed by the backward folding of the otoparietal plate is encrusted with calcifications and constitutes the lateral side of the "club" or "horn" which lies above the occipital groove. The parietal spur is widely expanded, a condition which may be observed beginning in the juvenile. The club of *B. terrestris* is therefore made up of a broad parietal spur and a lateral portion formed by the otoparietal plate.

8. The interorbital ridges extend higher above the horizontal surface of the frontoparietal, more laterally into the orbit, and a more extensive bony cap is produced at the corner of the eye in *B. terrestris* than in *B. americanus*. In this respect *B. terrestris* approaches the structure of certain Mexican toads, such as *B. valliceps*, *B. marmoreus* and others.

Comparison between the crania of B. houstonensis, B. americanus and B. terrestris.

1. In *Bufo houstonensis*, the prootic resembles that of *B. terrestris* in shape, *B. americanus* in ossification. The dorsal surface is like *B. terrestris* in its flattened nature and in its posterior notch but, whereas the lateral portion of the otic capsule is thinned, flattened and cartilaginous in *B. terrestris*, it is not so in *B. houstonensis*.
2. The epiotic eminence in *B. houstonensis* is more like that of *B. terrestris* in size and position, intermediate between *B. terrestris* and *B. americanus* in its central cartilaginous area. The fenestra ovalis and operculum resemble those structures in *B. terrestris*.
3. In *B. houstonensis*, there is a connecting band between the temporal plate and squamosal head as in *B. americanus* but the dorsal edges of the connecting band and temporal plate are broadly separated with the space filled with cancellous bony material, forming a broad supratympanic ridge.
4. In *B. houstonensis*, the orbital portion of the otoparietal plate is very broad and the otoparietal ridge constitutes one-half of the postorbital ridge in contrast to its narrow extent in *B. terrestris*. The otoparietal plate is widely separated from the orbital plate of the perpendicular lamina. The exceedingly broad otoparietal ridge thus formed is distinctive.
5. The parietal spur is greatly expanded in *B. terrestris*. It is not so expanded in *B. houstonensis*.
6. The parietal ridge increases in breadth posteriorly in *Bufo houstonensis* as it does in *B. terrestris*.
7. The height of interorbital ridges above the frontoparietals in *B. houstonensis* is intermediate between that in *B. americanus* and *B. terrestris*.
8. The bony growth of ridges is cancellous in *B. houstonensis*, more compact in *B. terrestris*.

(Difference other than cranial)

9. The eggs are compartmented in *B. houstonensis* as in *B. ameri-*

canus but the egg strings are somewhat scalloped in *B. houstonensis*, not so in *B. americanus*.

10. The pattern of the dorsum in *B. houstonensis* is entirely different to that of either *B. americanus* or *B. terrestris*.

CONCLUSION

The structural similarity in crania of various species of toads of eastern U.S. which have been examined in the course of this study is striking in that one observes comparable features in different species such as have been pointed out between *Bufo houstonensis, B. terrestris* and *B. americanus*. The skulls of *Bufo americanus, B. fowleri* and *B. cognatus* appear to have common characteristics lacking in a comparison between *B. americanus* and *B. terrestris*. A hasty conclusion that such similarities indicate hybridization or intergradation between species should not be made without substantiating evidence. It seems more likely that in the course of evolution many similarities will remain and a species be characterized by certain *combinations* of features that are peculiar to it alone even though certain ones of these features may appear in other species also. It is further believed that certain fundamental structures such as the shape of the otic capsule are less likely to be altered by hybridizing or environmental influences than less constant structures such as cranial crests and may afford a basis for indicating ancestral relationships.

Bufo houstonensis has many cranial characters in common with *Bufo terrestris* and the possibility of the two having a common ancestry is not denied, but if so, it is believed that they have so long been separated and each has been so modified from the other that they no longer show subspecific relationship.

ACKNOWLEDGMENTS.

So many individuals have aided me in this study, both directly as it concerns *Bufo houstonensis* and indirectly as it deals with *Bufo americanus* and *B. terrestris* that it is not possible to do justice to all. First and foremost, I desire to thank Dr. Hobart M. Smith, who, through counsel, encouragement, help on reference material and loan of specimens has helped in every way that he could. Dr. T. Paul Maslin has read the manuscript and made valuable suggestions. Since the study has been contingent upon an adequate series of *Bufo houstonensis*, I desire to thank Mr. Werner Gottsch of Houston, not only for toad specimens but for encouraging others to secure them for me, including J. H. Tabony, Jesse Haver, and Walter J. Greer. Mr. John Wottring's especial aid has previously been acknowledged.

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A Rapid Method for Preparing Skeletons From Preserved Salientia

By OTTYS SANDERS

Frequently the development of a new method is as responsible for scientific progress as is the personal factor. Such is believed to be the case in the method herein described for preparing skeletons of Salientia. It was born of frustration because of inability to determine skeletal elements in skeletons prepared by maceration and by the dermestid method.

To achieve satisfactory results in either of the above two methods involves considerable time and fresh material as well. The maceration method works best when a disarticulated skeleton is prepared; the dermestid method leaves closely attached skin obscuring structure.

The method herewith described is simple, quick, works even better on alcoholic or formalin preserved specimens than it does on freshly killed Salientia, and the tools for its use are usually at hand. It involves nothing more than the use of solutions of sodium hypochlorite, such as are available as household aids under trade names such as PUREX and CLOROX. If this dissolving method is employed by others, the fact is not known by the author.

Detailed instructions for preparing skeletons by this method are unnecessary. The specimen should be skinned, defleshed as far as is practical, and then immersed in the solution in a closed glass jar. The strength of solution required is determined by the amount of dissolving desired and the bony structure of the skeletal part treated. Dilutions are made with water.

Crania of bufonids have been prepared by disassociating them from the vertebral column, skinning, removing larger muscle masses, and then immersing in PUREX of full strength. When fully cleaned they were removed to water and subsequently dried. The dissolving process works better when the solution is warm, either through air temperature or by mixing with hot water. By this process eight or ten bufonid crania have been prepared in a morning.

Dissolution may be arrested at any stage and cleaned skulls prepared with the cartilages intact. The solution denudes skin in such forms as *Bufo valliceps* and *B. horribilis*, shows up suture lines, and indicates relative amounts of ossification. It makes possible direct observation of progressive disarticulation of bony elements one from the other. It may be used to supplement and complete the cleaning of skeletons prepared by other methods.

Bones which remain too long in the solution may be completely decalcified and crumble, but few methods are completely fool-proof.

A further application of this method has been observed. When preserved frogs and toads were immersed in a hot solution containing equal parts of PUREX and hot water, skin and fascia between muscles were dissolved causing the muscle masses to stand out clearly from one another. It is suggested therefore that the method may have further application in myology, as well as in osteology, of Amphibia.

Herpetological Notes from Southeastern Texas

By Ed. V. Guidry

Since the year 1933, with the exception of the years 1942 through 1945, I have been collecting reptiles in most of the southeastern corner of Texas, comprising Jefferson, Orange, Newton and Hardin Counties. To my extreme regret very few records were kept until 1949. Beginning in March 1949, when the first specimen of that year was captured, and through the present date, October 6, 1952, careful records of all specimens found were kept and with several exceptions a specimen of each found in each county preserved.

Twenty-seven species and subspecies of snakes, six species of lizards, eight species of turtles and the alligator have been found.

The abundance of specimens seems to be fairly reflective of their occurrence in these counties, as from previous years' experience the number found of each conformed closely to records of the four years when accurate recordings were made.

The terrain of the area covered by these four counties ranges from the Gulf Coast marsh lands of southern Orange and Jefferson Counties to heavily wooded areas of sandy soil found in northern Newton and Hardin Counties. The Sabine River forms the eastern boundary of Orange and Newton Counties and the Neches River is the southern boundary of Orange County and extends through Jefferson and Hardin Counties. From these two rivers numerous tributaries extend throughout. The Sabine Lake is the eastern boundary of Jefferson County and the Gulf of Mexico is its southern boundary. So within an eighty mile radius excellent opportunities exist to find a large varied assortment of reptiles that would not usually be expected from such a small area.

To Mr. John Werler of the San Antonio Zoological Society I am greatly indebted for confirmation of identification of many of the snakes found, and to Robert J. Snock and J. E. Guidry for their able assistance in the field.

The records for counties marked by an asterisk are *new records*: those counties in which I have collected specimens and that were not listed among the locality records in Bryce C. Brown's *An Annotated Check List of the Reptiles and Amphibians of Texas* (1950).

Coluber constrictor anthicus (Cope). Three adult specimens of the Spotted Racer have been captured in the period mentioned. These were found in areas overgrown with brush and blackberry vines in the spring of the year. Although numerous specimens of *flaviventris* found in this same area often have white scales, the ground color has always been the same as in other *flaviventris,* blue-green anteriorly grading to brownish posteriorly. The *anthicus* have a blue-gray ground color consistent their entire length with the white scales scattered over the entire dorsal area. The abdomen is white with black spots. If the *flaviventris* with white scales are intergrades they tend to have more characteristics of *flaviventris* than of *anthicus.* Unfortunately no gravid specimen of *anthicus* has come into my possession.

In captivity they have fed readily on anoles and ground lizards and one small sparrow was accepted.

County record: Orange* (2 mi. S. Bridge City).

Coluber constrictor flaviventris Say. Very abundant in Jefferson and

Orange Counties and during period recorded two were found in Hardin County and one in Newton County. They are usually found in open fields where berry bushes and vines are plentiful. The ground color is usually blue-green anteriorly grading to brownish posteriorly with yellow to yellow-white abdomens. Many are found DOR in April and May and are often found in suburban areas.

In captivity, specimens feed very well on Anoles, birds, mice and eggs but none have accepted insects or larvae of any kind. One specimen laid a clutch of ten eggs June 9, 1952, of which seven hatched July 22, 1952.

County records: Jefferson* (Port Arthur; 5 mi. W. Port Arthur; Sabine; Port Neches; 1 mi. W. Beaumont), Orange* (2 mi. S. Bridge City; 5 mi. NW. Vidor), Newton* (Deweyville), Hardin* (3 mi. S. Silsbee).

Masticophis flagellum flagellum (Shaw). Found in equal proportions in all four counties, usually in wooded areas. Color varies from uniform chocolate brown to dirty gray. One specimen was found feeding on young birds in a nest located in a small shrub several feet off the ground. Another was caught while swallowing another small coachwhip.

Those in captivity have fed on mice, lizards and small birds. One clutch of eight eggs were laid July 17, 1952, all hatching August 30, 1952.

County records: Jefferson* (Port Neches; 1 mi. W. Beaumont; 3 mi. E. Port Arthur), Orange* (3 mi. S. Bridge City; 4 mi. NE. Vidor), Newton* (Deweyville; 2 mi. E. Call), Hardin (3 mi. S. Silsbee).

Diadophis punctatus stictogenys Cope. Only one specimen of this species has been found in all the years of collecting in this area. This was found under a board in a sparsely wooded area. It lived only fifteen days in captivity and refused all food offered.

County record: Jefferson* (4 mi. NW. Port Arthur).

Farancia abacura reinwardti (Schlegel). Although the abundance of DOR specimens denotes that the Mud Snake is common in most of this section, few specimens are captured and most of these at night in muddy ditches. One six-foot two-inch specimen was found swallowing a two-foot *Siren lacertina* at night near a small ditch.

In captivity *Siren* has been the only food accepted with the exception of one small snake which fed well on the tadpoles of *Rana clamitans*. One large specimen lived thirteen months without eating.

County records: Jefferson* (3 mi. S. Port Arthur; 5 mi. W. Port Arthur; Port Neches; 5 mi. N. Sabine Pass), Orange* (2 mi. S. Bridge City; 10 mi. W. Vidor), Newton (5 mi. E. Mauriceville).

Elaphe obsoleta confinis (Baird and Girard). A common snake in this locality inhabiting varied terrain of marsh, farm areas, dense woodlands and even urban areas. Ground color of this Rat Snake varies from gray to yellow and occasional specimens of almost black have been found. Have discovered specimens in the process of eating birds and rats and many in poultry houses gorged with eggs.

In captivity they feed readily on rats, mice, birds and eggs. From one clutch of fourteen eggs laid July 30, 1949, hatched twelve snakes October 3, 1949. The largest specimen found measured six feet and eleven inches.

County records: Jefferson (Port Neches; 10 mi. W. Port Arthur; 1

mi. W. Beaumont; 1 mi. E. Hampshire), Orange* (10 mi. W. Orange; 5 mi. NW. Vidor; 2 mi. S. Bridge City), Newton* (Deweyville; 2 mi. W. Call), Hardin (5 mi. N. Kountze; 4 mi. S. Silsbee).

Haldea striatula (Linnaeus). Numerous specimens of this Cone-nosed Snake have been found in these four counties, especially in the spring when flower gardeners or farmers are breaking the soil. Many are found in urban areas in flower beds and under boards where earthworms are plentiful. Color varies from brown to bright red-brown.

In captivity several have fed on earthworms and one ate a small *Scincella laterale*. Three broods of 3, 4 and 5 young have been born in captivity.

County records: Jefferson (Port Arthur; Port Neches; 5 mi. W. Port Arthur; 1 mi. W. Beaumont), Orange (Orange; Bridge City), Newton* (Deweyville; 2 mi. E. Call), Hardin* (4 mi. S. Silsbee; 5 mi. N. Sour Lake).

Heterodon platyrhinos (Linnaeus). Common in all four counties in varied terrain and with many color variations. Those found in marshy areas are usually dark olive-green, while specimens from sandy, wooded sections possess bright orange, red or yellow markings. One of the first snakes appearing, often found in late February and early March. One specimen captured mating on March 28, 1950 laid seven eggs June 1, 1950, but none of the eggs hatched. Have frequently been found eating toads, which are very numerous in this section, and one was found eating a small frog.

In captivity they feed very well on toads but ignore frogs.

County records: Jefferson* (Port Arthur; 5 mi. W. Port Arthur; 2 mi. N. Sabine; 1 mi. W. Beaumont; 3 mi. E. China), Orange (2 mi. S. Bridge City; 4 mi. NE. Vidor), Newton* (Deweyville; 2 mi. E. Call), Hardin (8 mi. SW. Silsbee; 5 mi. NE. Saratoga).

Lampropeltis c. calligaster (Harlan). A few specimens of this King Snake are caught every year in Jefferson and Orange Counties and as many are found DOR. Those found usually are in open fields and suburban areas. One specimen dissected on June 17, 1951, contained eight eggs.

Captive specimens have occasionally eaten young sparrows, but ordinarily do not eat well.

County records: Jefferson (Port Arthur; 5 mi. W. Port Arthur; Port Neches), Orange* (2 mi. S. Bridge City).

Lampropeltis getulus holbrooki Stejneger. One of the very common snakes of Orange and Jefferson Counties and occasionally in southern Newton County. Extremely variable in habitat, as many found near salt water marshes as in wooded areas. Many are found also in suburban areas. The markings of quite a few seem to indicate intergradation with *splendida*. Some have been found eating other snakes, birds, and chicken and bird eggs. One dissected specimen disclosed a small turtle (*Chelydra serpentina*). Mice, snakes, lizards, eggs and birds have been fed captive specimens which thrive very well. One clutch of five eggs was laid July 3, 1951, and four hatched August 22, 1951.

County records: Jefferson (Port Arthur; 5 mi. W. Port Arthur); Sabine; 15 mi. SW. Sabine; Port Neches; 1 mi. W. Beaumont), Orange*

(2 mi. S. Bridge City; 4 mi. NE. Vidor; 2 mi. SE. Mauriceville), Newton* (Deweyville).

Lampropeltis triangulum amaura Cope. Eighteen of these beautiful little King Snakes were found in a single afternoon in an area of approximately a square mile, in a heavily wooded section one mile north of Deweyville, Newton County. Without exception they were discovered by peeling loose bark from pine stumps. Prior to this occasion only four had been found in this locality, and these along sandy roads at night. Since then, eight more have been taken in this same area. The smallest measured five inches and the largest twenty-six inches. This species of King Snake seem to be entirely nocturnal as all specimens found out of concealment were taken either in the early evening or at night. All snakes were found either in the month of March or in early April. Quite a few have irregular crossbands, in a diagonal position or broken in middorsal area.

In captivity they are fairly active and feed on ground lizards mostly and occasionally on small Anoles. One small *Haldea striatula* was also accepted. Much more active at night, staying under pieces of bark during the day.

County records: Newton* (1 mi. N. Deweyville), Hardin (10 mi. SE. Silsbee).

Opheodrys aestivus (Linnaeus). Common in all this section, found in usual environment of small trees, shrubs and hedges. Often found in urban areas. One of the last snakes of this area to go into hibernation as frequently they have been caught in late November.

Captive specimens have eaten nothing but caterpillars of the Monarch Butterfly although a wide variety of insects has been offered. Of a clutch of ten eggs laid August 28, 1952, seven hatched October 20, 1952. From another clutch of eight laid June 17, 1951, all hatched July 22, 1951. Thus the eggs laid later in the summer took eighteen days longer to hatch than the ones laid in June.

County records: Jefferson* (Port Arthur; Port Neches; 1 mi. W. Beaumont; 1 mi. N. Sabine; 5 mi. W. Port Arthur), Orange (2 mi. S. Bridge City; 4 mi. NE. Vidor), Newton* (Deweyville; 2 mi. E. Call), Hardin (4 mi. S. Silsbee; 5 mi. E. Kountze).

Natrix c. cyclopion (Dumeril and Bibron). Extremely plentiful in Jefferson and Orange Counties and frequently found in Hardin and Newton Counties. Next to *confluens* the commonest snake of this section and responsible for the belief that this area is infested with moccasins, which is erroneous, as ten *cyclopion* are found for each moccasin. Found equally abundantly in fresh and brackish water. Have been observed feeding on fish and frogs.

Captive snakes feed well on fish and frogs which they grasp as soon as offered. A brood of sixteen was born August 10, 1949. Another brood of nine was born July 16, 1952.

County records: Jefferson (2 mi. N. Port Arthur; 5 mi. W. Port Arthur; 3 mi. N. Sabine Pass; 8 mi. NE. High Island), Orange* (2 mi. S. Bridge City; 3 mi. SW. Mauriceville), Newton* (Deweyville), Hardin* (5 mi. SE. Silsbee).

Natrix erythrogaster flavigaster Conant. Found in all four counties, but seemingly much more prevalent in Jefferson County. Frequently speci-

mens have been found in wooded areas away from water. Can be found throughout the year as numerous specimens have been taken on sunny days in January and February, which are usually the coldest months for this section. Have been observed feeding on fish and frogs.

Feed well on fish and frogs in captivity also. A brood of eighteen was born September 9, 1952, and another brood of five was born the next day.

County records: Jefferson* (5 mi. W. Port Arthur; 3 mi. N. Sabine Pass; 1 mi. W. Beaumont), Orange (2 mi. S. Bridge City; 5 mi. SE. Vidor), Newton* (1 mi. N. Deweyville; 2 mi. E. Call), Hardin (5 mi. S. Silsbee; 3 mi. E. Kountze).

Natrix grahami (Baird and Girard). A few of these snakes are found each year in Jefferson and Orange Counties. Most are seen along roadside ditches in early spring.

Although one specimen ate freshwater shrimp on several instances, captive snakes have seldom accepted food given to them.

County records: Jefferson* (5 mi. W. Port Arthur; 2 mi. SW. Hampshire), Orange* (2 mi. S. Bridge City).

Natrix r. rhombifera (Hallowell). A common water snake found in all four counties, making an early appearance usually in March. Often seen eating fish and frogs and caught frequently by anglers on their lines. The specimens found in the southern part of this area have a darker orange or brown ground color than the northern specimens.

Captive specimens eat fish and frogs readily. One four-foot female gave birth to sixty-two young on September 10, 1950.

County records: Jefferson (5 mi. W. Port Arthur; 1 mi. W. Beaumont), Orange (2 mi. S. Bridge City; 5 mi. SE. Vidor), Newton* (Deweyville; 2 mi. E. Call), Hardin (5 mi. S. Silsbee; 2 mi. E. Kountze).

Natrix rigida (Say). Occasional specimens found in all but Hardin County. The least common of all water snakes in this area.

Captive specimens have refused fish and frogs.

County records: Jefferson (5 mi. W. Port Arthur), Orange* (2 mi. S. Bridge City), Newton* (1 mi. N. Deweyville).

Natrix sipedon confluens Blanchard x *fasciata* (Linnaeus). Specimens of *confluens*-like appearance are very common in all four counties, and *fasciata*-like specimens have been taken in all counties but Hardin. Quite a few of the *confluens*-like specimens appear intermediate between the two extremes. Often found in association with *cyclopion*. Have seen them eating fish and frogs.

Captive snakes also feed well on fish and frogs and thrive very well A brood of twenty-two was born October 2, 1951.

County records: Jefferson* (all fresh water areas), Orange* (2 mi S. Bridge City), Newton* (Deweyville), Hardin (5 mi. SE. Silsbee).

Natrix sipedon clarki (Baird and Girard). All of the specimens found have been taken in the brackish salt water areas along the Gulf Coast in Jefferson County. Seem to become more plentiful in the southern part of this area.

Captive specimens eat fish readily and several "cray-fish" have been accepted. A brood of six was born August 11, 1952.

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County record: Jefferson (Sabine Pass; 10 mi. SW. Sabine).

Storeria dekayi texana Trapido. Numerous specimens are found each spring in all four counties, usually under logs or loose bark and by gardeners in suburban areas. Often mistakenly called "ground-rattlers" by residents of this section.

Feed erratically on earthworms and meal-worms in captivity. A brood of three was born September 12, 1952.

County records: Jefferson* (Port Arthur), Orange (Bridge City; 5 mi. SE. Vidor), Newton* (1 mi. N. Deweyville; 2 mi. E. Call), Hardin (5 mi. S. Silsbee).

Thamnophis sauritus proximus (Say). This Garter Snake is extremely plentiful in all four counties, found in a great variety of terrain and often seen in suburban areas. Makes an early appearance usually in March and seen into November. Have been observed eating frogs on frequent occasions.

Captive specimens eat fish, frogs and sometimes small toads. A brood of nine was born August 9, 1949, and another brood of twelve was born July 30, 1952.

County records: Jefferson (no specific locality), Orange (no specific locality), Newton* (Deweyville; 2 mi. E. Call), Hardin (5 mi. S. Silsbee; 4 mi. E. Kountze).

Thamnophis ordinatus (Linnaeus). Five specimens of a red-sided subspecies have been found in Jefferson County and are being studied by Mr. John Werler. Captive specimens have fed well on fish and frogs.

County records: Jefferson* (NE. suburban Port Arthur).

Micrurus fulvius tenere (Baird and Girard). Specimens have been found in all four counties. More plentiful in sandy wooded sections of Newton and Hardin Counties. Those found in the daytime are usually concealed under logs or loose bark but several have been captured abroad in the late afternoon.

Do not feed well in captivity, occasionally eating ground lizards or small snakes.

County records: Jefferson (1 mi. W. Beaumont), Orange* (5 mi. SE. Vidor; Bridge City), Newton* (2 mi. E. Call), Hardin (4 mi. E. Kountze).

Agkistrodon piscivorus leucostoma (Troost). The water moccasin is found throughout this section, being very common in the marsh areas of Jefferson and Orange Counties. The great prevalence of harmless water snakes have exaggerated their number tremendously as the people of this locality have the tendency to call any snake seen in or around water a "moccasin." Have found several moccasins feeding on frogs and one large specimen found DOR was found to contain a large catfish.

Captive moccasins have fed on fish, frogs, mice and small birds. A brood of three was born August 14, 1951.

County records: Jefferson (5 mi. W. Port Arthur; Sabine; Star Lake; 1 mi. W. Beaumont), Orange (2 mi. S. Bridge City; Orangefield; 5 mi. E. Vidor), Newton* (1 mi. N. Deweyville; 2 mi. E. Call), Hardin (Honey Island; 4 mi. S. Sour Lake).

Agkistrodon c. contortrix (Linnaeus). Copperheads are common in all four counties, and especially in Newton and Hardin Counties. Thirty-

five were captured in a small area at night in Newton County, June 20, 1950. Very frequently found in pairs. Although they are numerous in and around camping sites, only four confirmed instances of people being bitten by copperheads in this section are known. In the early spring they are found almost entirely in the daytime but later they become nocturnal in their feeding and subsequently very few are seen during the day until early fall.

Captive snakes feed fairly well on mice and small birds but have refused frogs and toads. A specimen captured in the act of copulation May 3, 1952, gave birth to six August 19, 1952. Another brood of five was born August 21, 1952. Numerous broods have been born in captivity with an average of five.

County records: Jefferson (1 mi. W. Beaumont), Orange (5 mi. NW. Vidor; 4 mi. SE. Vidor), Newton (1 mi. N. Deweyville); 2 mi. E. Call), Hardin (5 mi. SE. Silsbee; 5 mi. SW. Kountze).

Sistrurus miliarius streckeri Gloyd. This ground rattler is fairly common in Newton and Hardin Counties and several have been taken in northern wooded areas of Orange and Jefferson Counties. A small child in Hardin County was bitten by a ground rattler during the summer of 1952; several weeks of hospitalization resulted.

In captivity specimens eat mice but refuse all other food offered. A brood of four was born August 15, 1949.

County records: Jefferson* (1 mi. W. Beaumont), Orange* (4 mi. SE. Vidor), Newton (2 mi. E. Call), Hardin (4 mi. S. Silsbee).

Crotalus horridus atricaudatus Latreille. Two six-foot specimens have been seen in Jefferson County. One fatally bit a small child near Labelle, and the other was killed on Tyrell Park Golf Course on the outskirts of Beaumont. Although reports have been heard of the presence of this rattlesnake in the other three counties, these are the only specimens I have seen in twenty years of collecting.

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County record: Jefferson (8 mi. NW. Port Arthur; 1 mi. W. Beaumont).

Anolis c. carolinensis Voigt. Abundant throughout all counties.

County records: Jefferson* (no specific locality), Orange (no specific locality), Newton* (Deweyville), Hardin (5 mi. S. Silsbee; 4 mi. E. Kountze).

Phrynosoma cornutum (Harlan). This horned lizard is found in southern Jefferson and Orange Counties. Not very common.

County records: Jefferson* (Spoilbank S. Port Arthur; 2 mi. NE. Port Arthur), Orange* (around Bridge City).

Sceloporus undulatus hyacinthinus (Green). Abundant in all wooded areas of these four counties.

County records: Jefferson (1 mi. W. Beaumont; 8 mi. W. Port Arthur), Orange (2 mi. S. Bridge City; 5 mi. SE Vidor), Newton* (no specific locality), Hardin (no specific locality).

Eumeces fasciatus (Linnaeus). Fairly common in all four counties.

County records: Jefferson* (8 mi. W. Port Arthur; 1 mi. W. Beaumont), Orange (2 mi. S. Bridge City), Newton* (no specific locality), Hardin (5 mi. S. Silsbee).

Scincella laterale (Say). Extremely common throughout.

County records: Jefferson (no specific locality), Orange (no specific

locality), Newton* (Deweyville; 2 mi. E. Call), Hardin (no specific locality).

Ophisaurus a. attenuatus Cope. Occasional specimens are found in southern Jefferson and Orange Counties.

County records: Jefferson (Port Arthur; 5 mi. W. Port Arthur), Orange* (2 mi. S. Bridge City).

Sternotherus odoratus (Latreille). Found in brackish water, ditches and bayous in all four counties.

County records: Jefferson* (5 mi. W. Port Arthur; 2 mi. N. Sabine Pass; 3 mi. N. Port Arthur), Orange* (2 mi. S. Bridge City), Newton* (Deweyville), Hardin* (4 mi. S. Silsbee).

Chelydra s. serpentina (Linnaeus). Common turtle found in all fresh-water areas and occasionally in brackish water.

County records: Jefferson* (2 mi. N. Port Arthur; 5 mi. W. Port Arthur; 2 mi. N. Sabine Pass), Orange (2 mi. S. Bridge City), Newton* (Deweyville), Hardin* (5 mi. SE. Silsbee).

Macroclemys temmincki (Troost). Fairly common in Jefferson and Orange Counties.

County records: Jefferson* (5 mi. W. Port Arthur), Orange* (2 mi. S. Bridge City), Newton* (Deweyville).

Deirochelys reticularia (Latreille). Three specimens were collected on the banks of a small irrigation ditch four miles west of Sabine Pass in Jefferson County.

County record: Jefferson (4 mi. W. Sabine Pass).

Pseudemys floridana mobilensis (Holbrook). This slider is found occasionally in southern Orange County and southeastern Jefferson County.

County records: Jefferson* (2 mi. N. Port Arthur; 2 mi. N. Sabine Pass), Orange* (2 mi. S. Bridge City).

Terrapene carolina (Linnaeus). Although the status of populations of this Box Turtle is undecided in this area of Texas, I have found numerous specimens of both *major*-like and *triunguis*-like appearance in Orange and Jefferson Counties.

County records: Jefferson* (Port Arthur; Port Neches), Orange* (Bridge City vicinity).

Dermochelys coriacea (Linnaeus). A huge specimen of this marine turtle was caught in a shrimper's net several miles south of Sabine in the Gulf of Mexico. I have seen smaller specimens caught by seiners in surf along the coast of Jefferson County also.

County record: Jefferson (2 mi. S. Sabine; 10 mi. SW. Sabine Pass).

Amyda ferox emoryi (Agassiz). Several specimens have been found in Orange and Jefferson Counties.

County records: Jefferson* (12 mi. SW. Port Arthur), Orange* (1 mi. N. Bridge City).

Alligator mississippiensis (Daudin). Abundant in southern Jefferson and Orange Counties. Hide hunters in recent years have killed hundreds in this area and seem to be causing a rapid depletion of a once very common sight in marshlands of south-central Jefferson County.

County records: Jefferson (10 mi. SW. Port Arthur; 5 mi. NE. Port Arthur), Orange* (Bridge City), Newton* (2 mi. E. Call).

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